THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

THE RIVER HUN

A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

DEVELOPED IN PARTNERSHIP WITH

Environment Agency

CONTENTS

Author: Olly van Biervliet of Norfolk Rivers Trust

Design: Ark Creative (UK) Ltd

THANKS

This plan has been enriched by contributions from many different people and organisations. Norfolk Rivers Trust would like to thank all those involved for their help:

Philip Amies
Andrew Brown
Gary Hibberd
Michael Meakin
Tim Holt-Wilson
Lorraine Marks
Helen Blower
Rory Sanderson
Charles Rangeley Wilson
John Dobson
Jonah Tosney
Sam Brown

INTRODUCTION

This plan has been produced by Norfolk Rivers Trust in consultation with the Environment Agency, landowners, and interested local people. The plan provides an outline for improvement of the ecological status of the Hun, guided by the Water Framework Directive. Delivery of the actions outlined in the plan will lead to improvements in the wildlife and amenity value of the river.

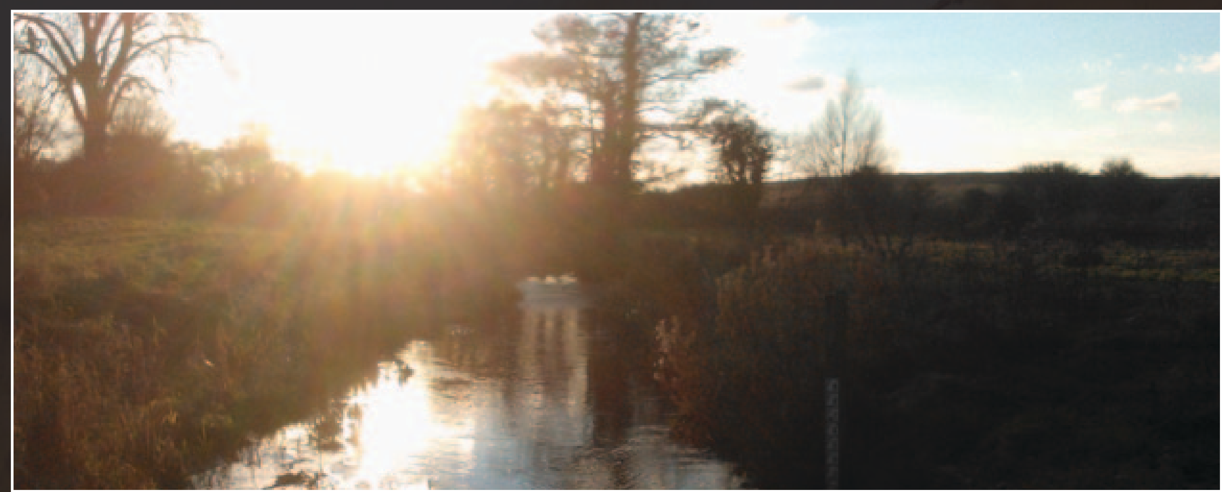
The plan begins by providing an audit of the current state of the catchment. Information gathered is then used to identify ecological pressures in the catchment. In the final stages of the plan, solutions to these pressures are identified, costed and prioritised.

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, groundwaters and lakes. 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. A majority of the UK's rivers currently fail to meet good status. In England, the Environment Agency are responsible for WFD delivery. Most streams are assessed by the Environment Agency in detailed Waterbody Reports, however, because the Hun is so short it has not been formally assessed. Despite its diminutive size, the River Hun is still important in its own right, and because it is an integral feature of two SSSI nature reserves, and is located within the North Norfolk Area of Oustanding Natural Beauty. In the absence of an Environment Agency Waterbody Report this Catchment Plan represents an attempt to bring together all the relevant information and to characterize the solutions to the significant problems which the river faces.

RIVER HUN STATISTICS

Approximate river length:	6 km
Protected areas:	SSSI (for Esker in Hunstanton Park; Holme Dunes Nature Reserve and Redwell Nature Reserve), Nature reserves and coast are also designated as: SAC, SPA and Ramsar sites.
Legal designations:	Bathing Waters Directive



SECTION 1 THE CATCHMENT

The Hun is a very short chalk stream (6 km) which carries its waters from its source in Hunstanton Park to the North Sea at its mouth in Holme Dunes National Nature Reserve. Wildlife abounds in the surrounding area with a profusion of birdlife in particular. Nevertheless, the river itself has been degraded by centuries of modification and would benefit considerably from ecological restoration work.

THE COMMUNITY

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.

The River Hun has a rural catchment, containing the towns and villages of Hunstanton, Holme-next-the-Sea and Thornham within the catchment. So far, we have 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 Hun

WHY RESTORE RIVERS?

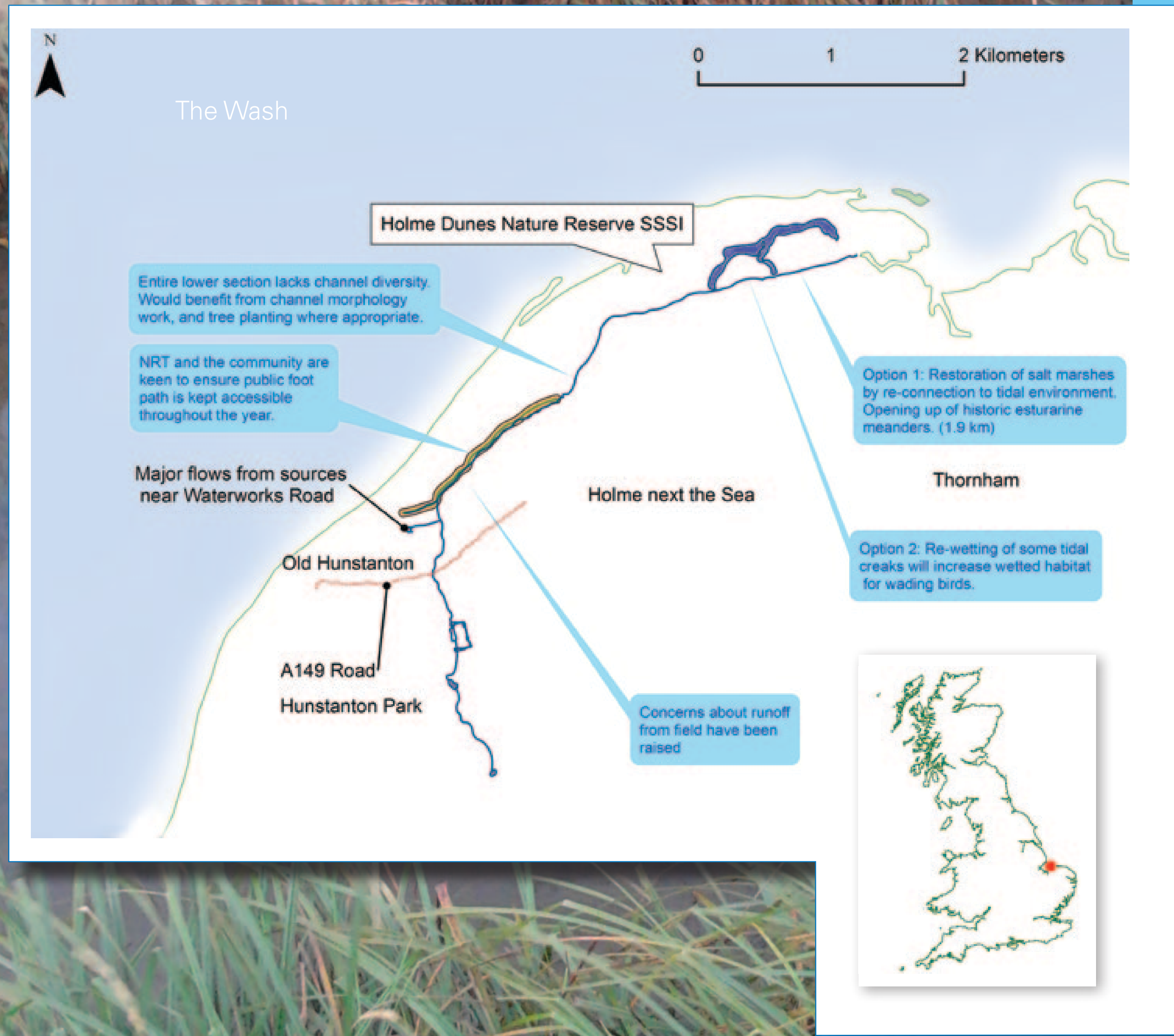
Britain's rivers generally fail to reach "good" ecological quality. This is both a problem in itself and a sentinel of trouble.

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 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 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.

OVERVIEW OF RESTORATIONS OPTIONS

Summary of possible restoration options on the river Hun. 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.



A GEOLOGICAL AND HUMAN HISTORY OF THE CATCHMENT

The landscape surrounding the Hun has been formed by powerful processes acting in the deep past. Overall, the landscape can be divided into a coastal plain, a slope (scarp) and a plateau dissected by now dry valleys caused by past erosion by streams during the Ice Age. The scarp was a sea cliff before the most recent ice age.

At Hunstanton Cliffs, the geological sequence is exposed. The basal Carstone is a sandstone with pebble beds. A red chalk (Hunstanton Formation) is overlain by younger white chalks (Photo 1).

During the Pleistocene period, 2.6 million to 11,700 years ago, there were some 8 ice ages, with this region either on the edge of the ice sheet or covered by deep sheets of ice which extended far to the south. Each ice age has eroded the deposits of earlier ice ages leaving us with a partial picture. Prior to the most recent Ice Age the Hun was a larger river which extended east of Ringstead. This changed when a large glacial lake which had formed at Ringstead burst its banks, and the resulting flood cut a new valley which flowed into the River Heacham. This "new" valley now forms in part NWT Ringstead Down nature reserve.

Hunstanton Park contains another fascinating relic of glacial times. This is a landform-type called an esker. An esker is formed by the sands and gravels derived from

Photo 1. Hunstanton cliffs.

the bed of an ice-age river running through the heart of a glacier. When the glacier finally melted, the gravels were deposited. Hunstanton Park Esker is about 1.5km long running from just north of Ringstead Down to Hunstanton Hall (Photo 2).

Photo 2. Hunstanton Park Esker (SSSI). The meandering form of the river can still be discerned in the winding form of the esker.

Some 7,400 years ago sea level started to rise, eventually flooding the area which is now The Wash, and which had been an area of woodland. Fluctuations of sea level are preserved in sequences of peat and marine clay found exposed on the modern beach at Holme.

The coastal plain was several kilometres wide during the Neolithic to Bronze Age (roughly 6000 to 4000 years ago). Freshwater reeds and alder woods developed from salt-marshes forming peat which was subsequently covered by marine clays as the sea covered the area. These fluctuating conditions have preserved a rich series of wooden artefacts including the well-known Sea Henge at Holme.

During this period, human settlements existed on the higher ground and woodland was cleared over much of the area. By the Iron Age (some 2,500 years ago) the coastline was similar to today, and it is likely that woodland had been almost completely cleared. Grazing by livestock on steep chalk and nutrient-poor glacial sands formed an extensive series of downs and heaths which were managed as common land. The chalk rich till and the gentler slopes with deeper soils were eventually brought into open field management.

Poorer soils could be farmed with the addition of lime (hence chalk pits) which could make some of the easily ploughed light soils of the glacial sands available for arable farming for a few years before nutrient levels dropped and grassland would be re-established. Such areas, known as Brecks, have been recorded at Ringstead. The basis of farming was the transfer of nutrients from the commons (coastal saltmarsh and dunes and the heaths and downs) to the cultivated arable fields. This was enabled by sheep which were being grazed by day on the commons (and open field fallow) and penned at night in a fenced enclosure in the arable field which is then fertilised by their dung this practice is called sheepfold.

Some enclosure occurred by agreement in the Medieval period. Hunstanton Hall and park also developed. Evidence such as moats and documents of other medieval manors exist, suggesting there was a complex pattern of landownership and manorial rights.

The open fields were productive and supported a relatively dense human population. The Doomsday population density for the Hunstanton area is amongst the highest in England.

During the late 1700s and early 1800s a series of enclosure awards reorganised this landscape with many of the commons disappearing. Sheep were still the basis of fertility but crops such as turnips and rape (used with clover rotations) replaced the commons and fallow.

In the 1630s Sir Nicholas Le Strange and the Dutch engineer Van Haesdonck built a series of sea banks from Thornham through Holme to Hunstanton which enabled an area of marsh to be drained. A sluice excluded tidal inflow totally from the river upstream to Hunstanton Hall. The river was canalised from Hunstanton Hall to the sluice and drainage ditches constructed in the river valley marshes. These sea banks enabled drainage of some 60 acres of wetland.

Holme was enclosed in 1820 though this had a limited impact on the coastal common and the river downstream of the sluice. In 1860 a large part of Hunstanton and Holme Common was enclosed, and an embankment was created from the older 1630 wall west of Thornham Staithe road towards the north, joining the dunes near the east of The Broadwater (a former tidal creek).

The river was diverted to flow south of its old course at Beach Road, Holme, and was canalised in Holme parish and the surrounding land drained. The resulting Polder grasslands remained grassland until the 1960s when some arable cultivation developed. The area has now reverted to cattle grazed grassland. The lower Hun was substantially deepened during World War 2 in order to act as a barrier to enemy assault by tanks.

More recently, The Norfolk Wildlife Trust and The Norfolk Ornithological Association have created a number of pools and reedbeds by re-flooding old creeks. These are fed by springs found at Redwell and Holme Marsh, pumping of water abstracted from the River Hun and . The hard work of these conservation groups has helped to reinstate a vibrant wildlife community in the area.

Contribution: Philip Amies,
with thanks from Norfolk Rivers Trust

Painting of barge being unloaded near Hunstanton, Peter de Wint©, early nineteenth century

WILDLIFE SURROUNDING THE HUN

The grazing marshes around the mouth of the Hun are a haven for wildlife. Birds, amphibians, mammals and invertebrates thrive in this highly productive area along with a profusion of plantlife. The area supports a thriving population of Natterjack toads, one of less than 20 such sites nationally.

Iconic species such as bittern and marsh harrier inhabit Holme Marsh. Ducks such as mallard, gadwall, shoveller, shelduck, tufted duck, and pochard also breed in the marshes. Breeding waders include oystercatcher, lapwing, avocet and redshank. Large flocks of pink-footed geese, brent geese, wigeon, teal and curlew are present in the winter.

Moreover, a colourful array of dragonflies and damsel flies beguile visitors to the marshes. These include ruddy darter, common darter, emperor dragonfly, banded demoiselle, emerald damselfly, common and azure damselfly. Lunar hornet moth (lava feeding on willow trunks) and hornet moth (lava feeding on poplars) are found in the river valley, these impressive moths are good mimics of hornets. A number of scarce plants are also found, including marsh orchids and a variety of wetland species.

Photo 5. Bittern, *One of Britain's most threatened animals, the Bittern is a secretive bird inhabiting reed beds. It quietly stalks and fish, amphibians and insects during most of the year. The male has an incredible, booming call during the spring.*

Photograph: © Philip Ames

Photograph: © Philip Ames

Photo 3. Pink footed geese.

Photograph: © Jack Perks

Photo 4. Banded demoiselle, a riverine species frequenting the Hun and its grazing marshes.

Photograph: © Philip Ames

Photo 6. Spoonbill, *"Watching a flock of spoonbills feeding on a shoal of sticklebacks is impressive. The flock moves in a rough line sweeping their bills and constantly catching and swallowing small fish eating hundreds of them. At times it gets really frantic and they catch a fish on almost every sweep."* Philip Ames.

Otters are starting to be recorded more frequently, kingfishers winter in the area (up to 6) and water voles are found in good numbers along the river and in marsh ditches. Barbastelle bats have been recorded using the river valley. This is a rare species which uses long linear feeding habitats such as coastal grassland or river valleys flying considerable distances (8 – 14 miles). Natterjack toads enrich the soundscape, calling loudly at dusk from the marsh.

In summary, the marshes surrounding the lower Hun represent a thriving ecosystem, which gives pleasure to innumerable local people and visitors alike.

Contribution: Philip Ames,
with thanks from Norfolk Rivers Trust

WILDLIFE PROFILES

Wildlife profile:
The Eurasian Otter, *Lutra lutra*

The otter is a predatory mammal which uses its excellent swimming ability and specialised teeth to feed on a variety of prey such as fish but also amphibians and occasionally birds. They have even been shown to be capable of eating toads despite their poisonous skins. They corral the amphibians into groups before proceeding to skin them and eat the nutritious innards. Otters hold territories against the same sex, and this stops their numbers building up into high densities, especially when food is scarce. This beautiful and reclusive animal is wide ranging and can be seen around ponds, lakes, rivers and marine habitats. Text, Mark Rylands,

Photograph: © Jack Perks

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.

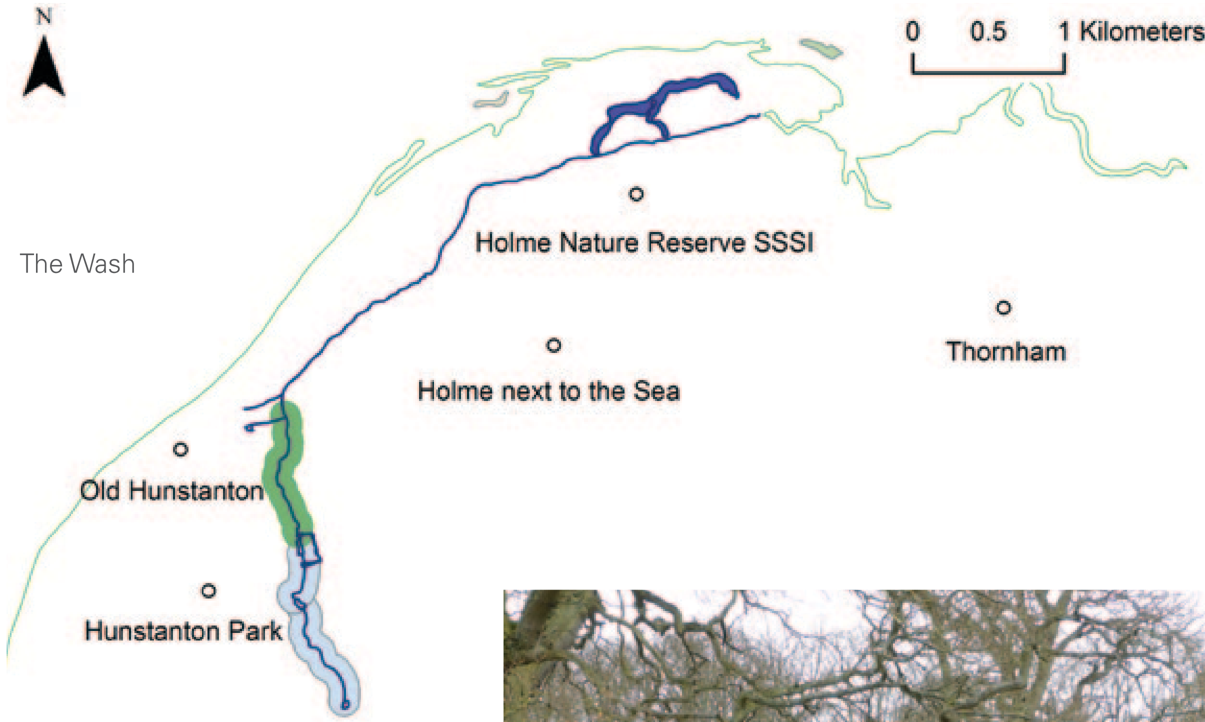
Water plants cause flow variation which also encourages sediment storage and scour.

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

THE HUN FROM SOURCE TO MOUTH

From source in Hunstanton Park – A149 Road Bridge

This section of the River Hun is predominantly a seasonally running stream with permanent flow only originating just above the A149 road bridge. Such streams, where flow is seasonal, are called winterbournes. This section predominantly follows a natural form, defined only by a gentle undulation and no clear channel. It is not a useful concept to think of a winterbourne as having one particular source all the time. Rather, as one reaches the uppermost sections, the point of first flows moves up the course as groundwater level increases. Flows are augmented by side-channels during wet periods. The surrounding land is estate park land which is grazed by sheep. The stream runs through several shallow ponds and eventually into the moat of Hunstanton Hall, from which point onwards the stream becomes heavily modified. Some ponds which are ephemeral, have very clear water, but the moat and more permanent ponds have black, bacterial waters. Below the hall the river is channelized and deepened as it flows through a damp meadow, and past a lake towards the road bridge.



River Hun with upper section highlighted. Light blue shows the winterborne (ephemeral) section of the river and dark green marks the permanent section.

Photo 9. The uppermost source along the winterborne section or the river forms a pond, and can feed the stream through the depression in the foreground when levels are high.

Photo 10. Subtle depression in the ground where the ephemeral section of the stream flows when the water table is high.

Photo 11. Permanent pond with black bacterial waters.

Photo 12a and b. Crystal clear water entering the Hun from an ephemeral groundwater-fed pond during higher water levels and joining the main river course.

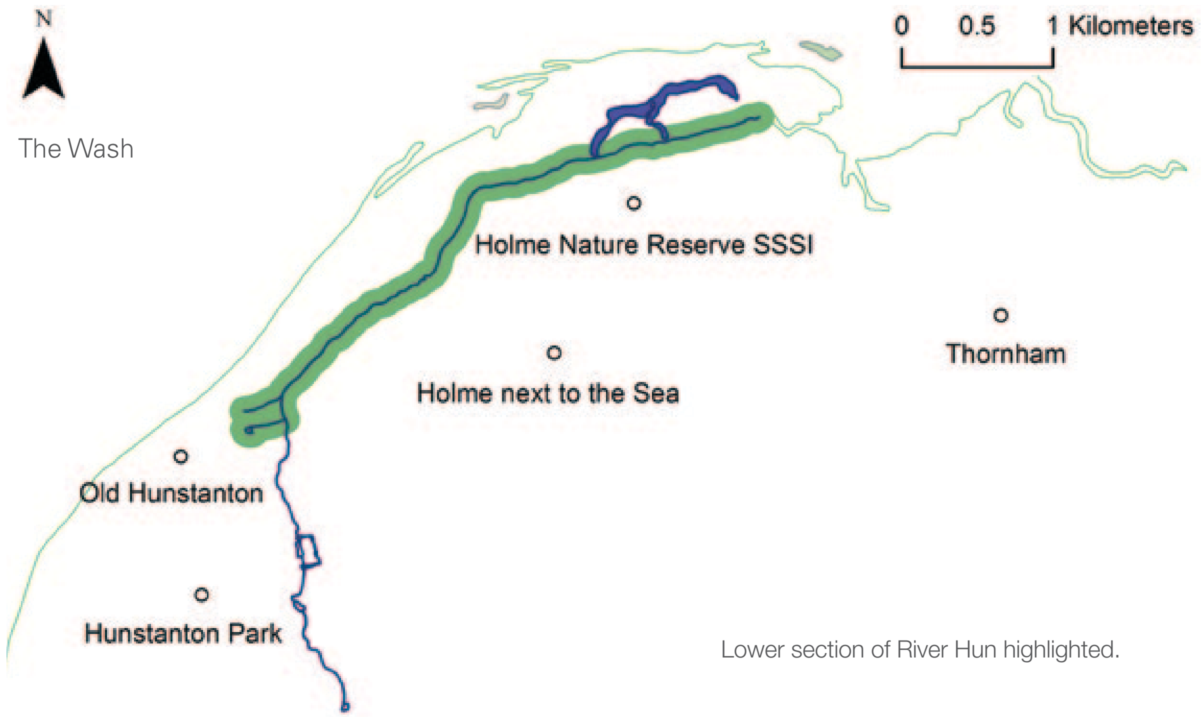
Photo 13. River enters moat at Hunstanton Hall at Hunstanton Park.

Photo 14. River in deepened and vegetated channel below the moat.

A149 Road Bridge – start of Holme Dunes National Nature Reserve

Below the road bridge several springs contribute to a substantial increase in flow. A majority of water in the Hun arises from the clear flows of the springs which are located near Waterworks Road, as shown in Photo 17. A ditch running adjacent to the golf course, which also functions as a storm drain brings more water. The surrounding land use in this section is comprised of rough grassland, and an arable field to the East, and a golf course to the West. The river is very deepened and has a straight-sided banks from where the springs at Waterworks Way join the flow, with a featureless silty substrate. There is a public footpath through much of the section of river, however this amenity is constricted by the golf course's fence on one side and the river bank on the other. Parts of the path have been supported by revetments because the path is too close to the river's edge and would subside. Moreover, in the summer months the path is not kept clear, and so is overgrown. This means that it is not an enjoyable walk for locals who have voiced their dissatisfaction with the path.

The majority of this section flows through an artificial landscape because it is a tidal area which has been reclaimed from the sea. Historically the river would have flowed through freshwater and salt water marshland, and the consequent a lack of gradient has important implications for any restoration options.



Lower section of River Hun highlighted.

Photo 15. Below A149 road bridge.

Photo 16. Immediately downstream of the A149 road bridge there is a diversity of vegetation and flows in this slightly "wilder" section of the river.

Photo 17. Flows of clear, high quality water originating from springs close to Waterworks Road.

Photo 18. A representative picture of the silty and canalised lower Hun below the confluence with flows from Waterworks Road.

Photo 19. A representative picture of the silty and canalised lower Hun.

Holme Dunes National Nature Reserve

Holme Dunes Nature Reserve and Redwell Marsh Nature Reserves are Sites of Special Scientific Interest, designated for the quality of the habitat which they provide for birds. The Hun runs in a straight line through this area and remains deepened and channelized. The fringes are bordered by reeds, thus providing some ecological value as refuges for invertebrates and birds.
The tidal outfall is through a sluice, and the Hun then flows through tidal creeks to the sea.

Photo 20. Old creeks and scrapes provide excellent bird habitat.

Photo 21. Broadwater, a lake which was probably a tidal meander of the river in the past.

Photo 22. The Hun just upstream of the tidal sluice.

Photo 23. Tidal sluice at Hun outfall.

Photo 24. Tidal section of River Hun.

SECTION 2 THE PROBLEMS AND SOLUTIONS

The natural state of the river Hun is best understood by imagining the landscape without the tidal wall. The stream would flow from its gentle beginnings as a diffuse area of steadily-moving shallow water, and would be gradually met by more springs. It would rapidly have met freshwater marshland which would have backed up from the salt marshes which themselves would have been much further inland. The ecological value of this area would have been great, providing extensive breeding habitat for birds and nursery areas for young fish. Sea bass, grey mullet and wading birds would thrive in such an environment.

RIVER STRUCTURE

The upper part of the river is unusual in that the winterbourne section probably resembles a natural form. All too often upper sections of winterbourne rivers have been converted to ditches, and it is good to see this sensitive management of the river throughout most of Hunstanton Park.

By contrast, the area below the confluence with the springs from Waterworks Road is straightened and artificial. In the lower river, there is a 1.3 km section of river which is absolutely straight. Little is known about the biological community of the river, due to a lack of consistent monitoring of key groups such as water plants, fish and invertebrates. However, it appears likely that these communities are very impoverished as a consequence of the poor habitat.

Due to the heavily deepened and engineered nature of the channel, and its low gradient, it would be very technically challenging to increase the sinuosity of the channel overall. However, the over-capacity of the channel means that there might be scope for the stream to gain some sinuosity within the channel. This could be achieved by re-grading the banks of the channel to a more gradual form, and using the material gained through doing this to make low-level platforms ("berms"). Material would also be used to narrow the river in places to increase variability in flow speeds. This could be encouraged by the addition of stable woody material which would constrict the river flow in some places and create pools in others. An image of how this might look is shown in Figure 1. The variety of different habitats, and the shelter provided by the woody material itself would increase the biological richness of the stream.

In the lowest part of the river, reconnection with historic meander bends of the river (visible in Figures 3 and 4) might be desirable in the long term if flood defences were retreated ("managed realignment").

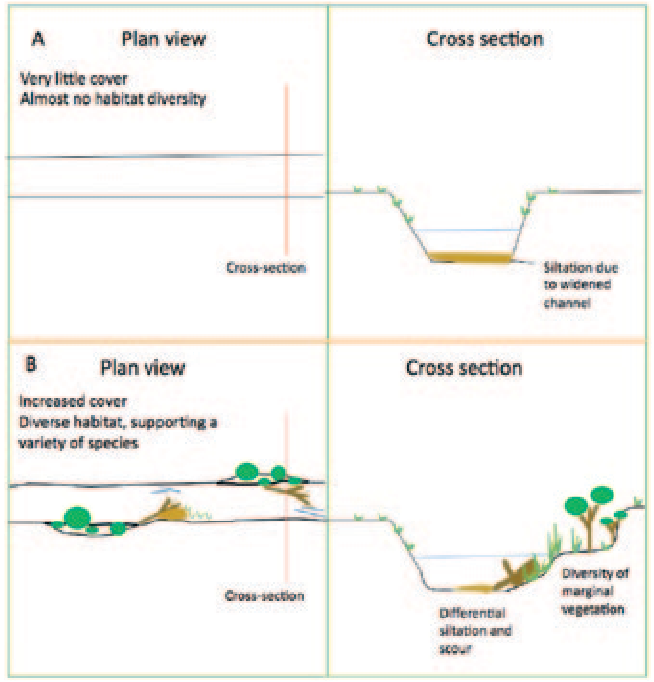


Figure 1. Schematic showing: A. The siltation and poor habitat caused by the current form of the river channel. B. Potential improvements to the straightened river channel which would improve habitat diversity and wildlife value in the long term. Nearer the nature reserve, tree planting might be considered less appropriate by the managers of the reserve, so natural colonisation of low-level platforms by water plants might be more appropriate.

CONNECTIVITY BETWEEN THE RIVER AND THE SURROUNDING LANDSCAPE

The extensive wetlands which would have occupied this area have been largely lost. Reinstating these wet areas which would once have been connected to the river would be very valuable for the wildlife community. To discuss this, we will divide the lower river into two "Zones". Firstly, the stretch of the river between the confluence with sources from Waterworks Road to Beach Road (Zone 1) can have its structure re-habilitated (Figure 1). This would increase marginal habitat, essentially giving the river a mini-floodplain zone. Somewhere below Beach Road (Zone 2: the exact point would have to be determined by careful consultation and hydrological modelling) full return of the area to salt marsh ("managed realignment") may be the most sustainable option. If this option was chosen then re-connection of tidal meaders (e.g. Broadwater Pool) would be desirable. This option would connect the river to the tidal cycle, enabling the rich ecological interchange which has been lost from the area. This would restore the river's wildlife community to its natural state. Having this increased volume to absorb tidal surges might also reduce flooding risk from adjacent areas of coastline. If managed realignment option is not possible, some channel structure work within the reserve as well as raising of the water levels could re-wet some of the historic creeks with freshwater, thus further extending marginal habitat (see Action Plan section for details).

WATER QUALITY

Limited point-samples of the Hun's water quality suggest that it is relatively low in nutrients and good in quality. *Ad hoc* samples taken between September 2013 and March 2014 indicate that levels of salinity do increase close to the tidal sluice, but not at concentrations which are damaging to freshwater wildlife (Figure 2). However, interested local people report that sediment can be seen washing into the stream from drains which lead from an arable field to the south of the river during rainfall events. Monitoring during such events would be useful to determine to what extent this is a problem.

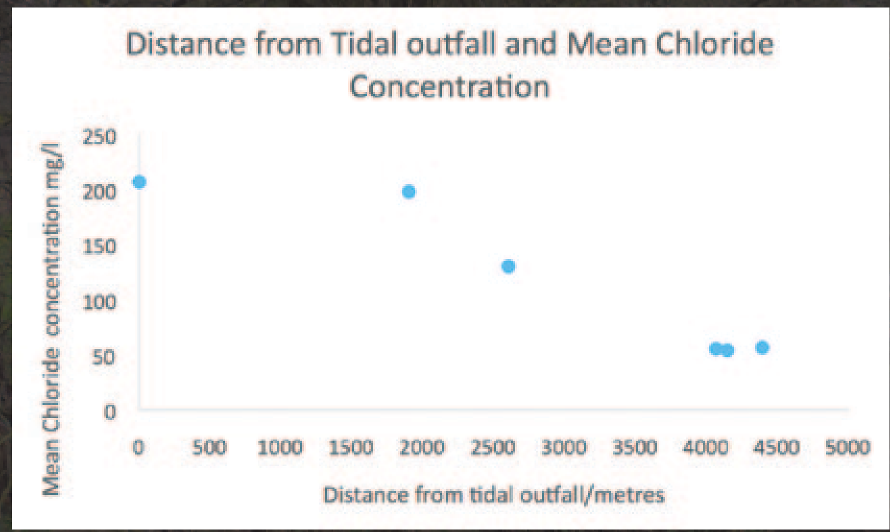


Figure 2. Salinity changes as distance from tidal sluice increases. Sea water has a concentration of around 19,000 mg/l of chloride, and concentrations in the low hundreds are not thought to be damaging to wildlife such as plants or invertebrates.

FISH PASSAGE

In terms of barriers to fish passage, the tidal sluice could represent some impediment to fish passage, however the significance of this has not been quantified. Flounder are frequently observed close to Redwell Nature reserve, demonstrating that the structure is passable.

ECOSYSTEM

Very little is known about the aquatic ecosystem in the River Hun due to a lack of biological surveys. Generalist aquatic vegetation such as water starwort (Callitriche sp), sedge species *(Carex sp.)* and fool's watercress (Apium nodiflorum) have been observed during walkovers. More specialist chalk stream vegetation may be excluded due to siltation. Reports from stakeholders show that vegetation undergoes a major seasonal dieback below the golf course. Water quality monitoring has been undertaken to determine whether saline intrusion could be the cause, but this does not seem to be the case (see previous section). Interested stakeholders also suggest that appreciable amounts of sediment has washed into the stream in the past from the arable field to the south of the stream. It is likely that the stream would not be able to clear such sediment given the current over-widened structure of the stream.

The lower river represents poor habitat for most aquatic species due to the lack of cover such as that provided by trees or submerged water plants. There is also very little variation in substrate or flow velocities. Finally, as the stream waters back up behind the tidal sluice gates at high tide there is a daily rise and fall in water levels which seems to be about 30 cm. The nearly vertical banks of the stream extenuate the speed of this rise and fall, and make the environment yet-more-challenging for freshwater plants which are not well adapted from this frequency and intensity of water level change.

INVASIVE SPECIES

Invasive species have not been observed in or around the Hun as part of river walkovers. However, Himalayan balsam and giant hogweed have been found in the adjacent Heacham catchment. Norfolk Rivers Trust always appreciate it when people report the presence of invasive species, and can often mobilise volunteer groups or relevant authorities to deal with the problem.

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).'

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.

Giant hogweed

Photograph: © Olaf Booy

Photograph: © Mike Sutton-Croft

Himalayan Balsam (Impatiens glandulifera).

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 early in the season before seed pods have emerged 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. 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.

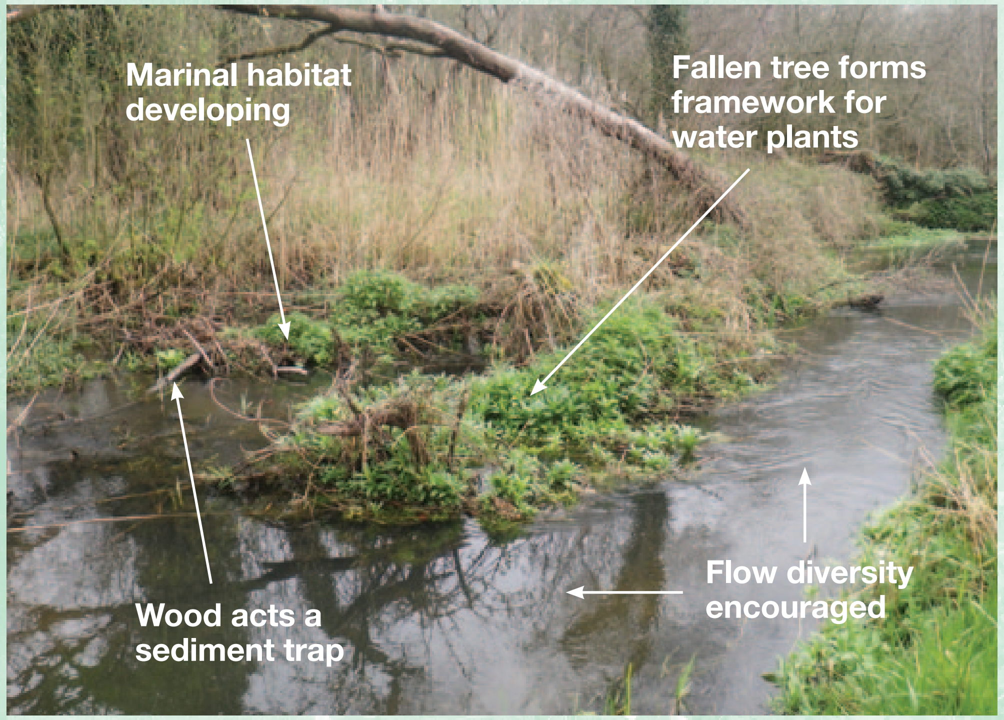
TREES AND WOODY HABITAT

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, oxygen levels decrease in water and this can cause death of aquatic organisms. Small streams such as the Hun are especially vulnerable. 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 also 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) initiates 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.

Tree planting could be of great benefit to the habitat quality of the River Hun for both aquatic and riparian wildlife. However, trees need to be placed strategically in sections of river which do not impact ground nesting birds within the nature reserves.



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

Actions for the River Hun should take into account local people's views, current land usage, and aim to enhance the ecological potential of the river.

In the future, the River Hun could have a rich ecological interchange with its surrounding environment, which would be enhanced by natural processes and would support a wider range of birds, fish and invertebrates. Upstream of Holme next the Sea, the stream channel itself could have increased sinuosity with a patchwork of shade, and different water velocities. This would improve the nursery and breeding habitat for fish and invertebrates. Below this point, restoration of the tidal flux to the area would restore large areas to highly biologically productive and valuable salt marsh. To facilitate this, actions should focus on the river below the confluence with waters from the Waterworks Road. Two zones are discussed which could be approximately located as follows:

Zone 1: From the confluence of springs at Waterworks Road with the Hun to Beach Road Bridge.
Zone 2: Downstream of Beach Road Bridge.

ZONE 1: FROM THE CONFLUENCE OF SPRINGS AT WATER-WORKS ROAD WITH THE HUN TO BEACH ROAD BRIDGE.

Four main measures would enhance the amenity and wildlife value of this stretch or river:

1. Pull back fencing 10 m from the river on both sides. The public footpath and river corridor are currently too restricted to have much value. The footpath should also be kept clear of high vegetation because it is currently hazardous and unpleasant to use during the summer.
2. Improve channel structure by re-grading the river bank which is currently too steep and put in place lower-level berms.
3. Introduction of a wetland mosaic including backwaters and off-stream ponds to emulate the wetland environments that would have been present in this section and would greatly increase the biological diversity in the landscape.
4. Strategic tree planting for provision of dappled shade and woody material in the long-term future.

The advantages of these measures are explained more fully the Problems and Solutions section. The expansion of a reasonable river corridor would make this area a community space which would be far more enjoyable to use. Wildlife such as moorhens, otters and water voles would also benefit from this enlarged area. The enhanced river structure would change this section from what is currently a drainage channel with almost no ecological value back towards being a biologically diverse and aesthetically pleasing chalk stream. Finally, tree planting would provide woody material and cover in the long term. Well positioned trees could also provide a degree of protection for walkers who currently face the risk of being hit by golf balls from the golf course. However, trees should be strategically placed to avoid providing perches for predatory birds which could impact ground nesting birds in the nature reserves. Species of tree such as alders, willows and blackthorn bushes would be appropriate in this area.

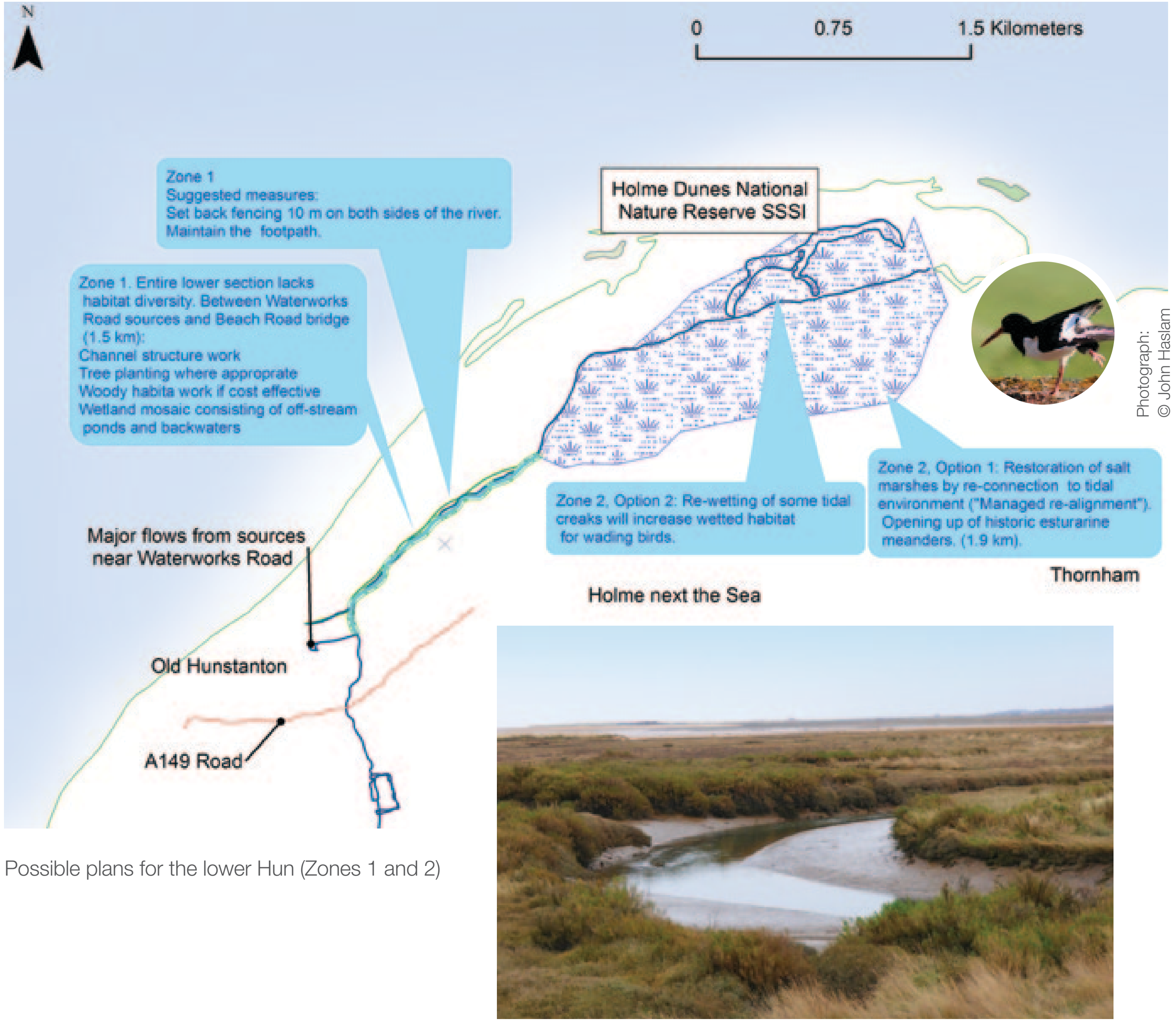
ZONE 2: DOWNSTREAM OF BEACH ROAD BRIDGE (OPTION 1)

Whilst some of the worst aspects of channel modification can be mitigated by piecemeal intervention, restoration of the habitat would involve returning substantial parts of the lower parts of the Hun and surrounding land to estuarine salt marshes. This would involve retreat of tidal sluice gates. This measure would be in sympathy with the history of the landscape, and would be underpinned by natural processes, most notably the tidal cycle which would allow natural recovery of the river system and surrounding area. It is possible that such a scheme could be planned as so to reduce flood risk in Hunstanton and other nearby centres of population. In Norfolk the common occurrence of unidirectional sluice gates (which in many cases are essential for flood defence) mean that there is only a restricted transitional zone between freshwater and tidal environments. As a result, opportunities to restore a naturally functioning transitional zone are very valuable for enhancing the biological integrity of these naturally estuarine environments.

In a tidally inundated lower River Hun, marine fish would mingle with freshwater species in a highly productive environment. In particular, species which are adapted to exploit this type of transitional environment such as grey mullet and sea bass would find this area a haven. Birds would also prosper from the bounty of the revitalised brackish environment. Moreover, the river could be encouraged to re-join its historic meanders without the need for intensive water level management.

This is certainly a long-term vision for the river, but with sea level rise progressing at approximately 4 mm per year due to isostatic mechanisms (Norfolk's land mass is sinking in a long-term response to the last glacial), it may become necessary for pragmatic reasons. Certainly, there would be a retreat of some freshwater species, but others would be gained. It is outside of the scope of this catchment plan to suggest a detailed and itemised plan with specific locations suggested for restoration of an estuarine and salt marsh environment. However, we hope that this suggestion will form the basis for a discussion with interested parties.

The area is a matter for a wider discussion about costs and the choices of the community. The current plan according to the Shoreline Management Plan (Further information: http://www.eacg.org.uk/) is to maintain current sea defences in this area.



Possible plans for the lower Hun (Zones 1 and 2)

ZONE 2: DOWNSTREAM OF BEACH ROAD BRIDGE (OPTION 2)

Within the nature reserve there could be some scope re-flooding of historic creeks. Features such as Hun Pool and Broadwater Pool are the old tidal meanders of the River Hun itself and are clearly seen on Figures 3 and 4. It has been suggested by managers of the nature reserve that re-wetting some historic creeks by raising water levels using a sluice would be desirable for bird habitat and could be achieved using an existing sluice. From an initial assessment, it appears that water levels in the lower river would need to be raised by around 50 cm to increase the wetted area effectively in the creeks investigated, shown in Figure 3. This may be excessive, so some physical reduction in the height of the beds of the creeks may be required, which will allow water to flow into lower areas. Depending on the eventual increase in levels suggested, other creeks may also be re-wetted as a result, for instance those show in Figure 4. A hydrological modelling exercise would be needed to determine if this was appropriate to the area. A more ambitious plan put forward in a report by UEA in the early 1990's suggested more extensive channel morphology work, but NRT believe that this is only worth the expense if it forms part of a more comprehensive plan for the lower river.

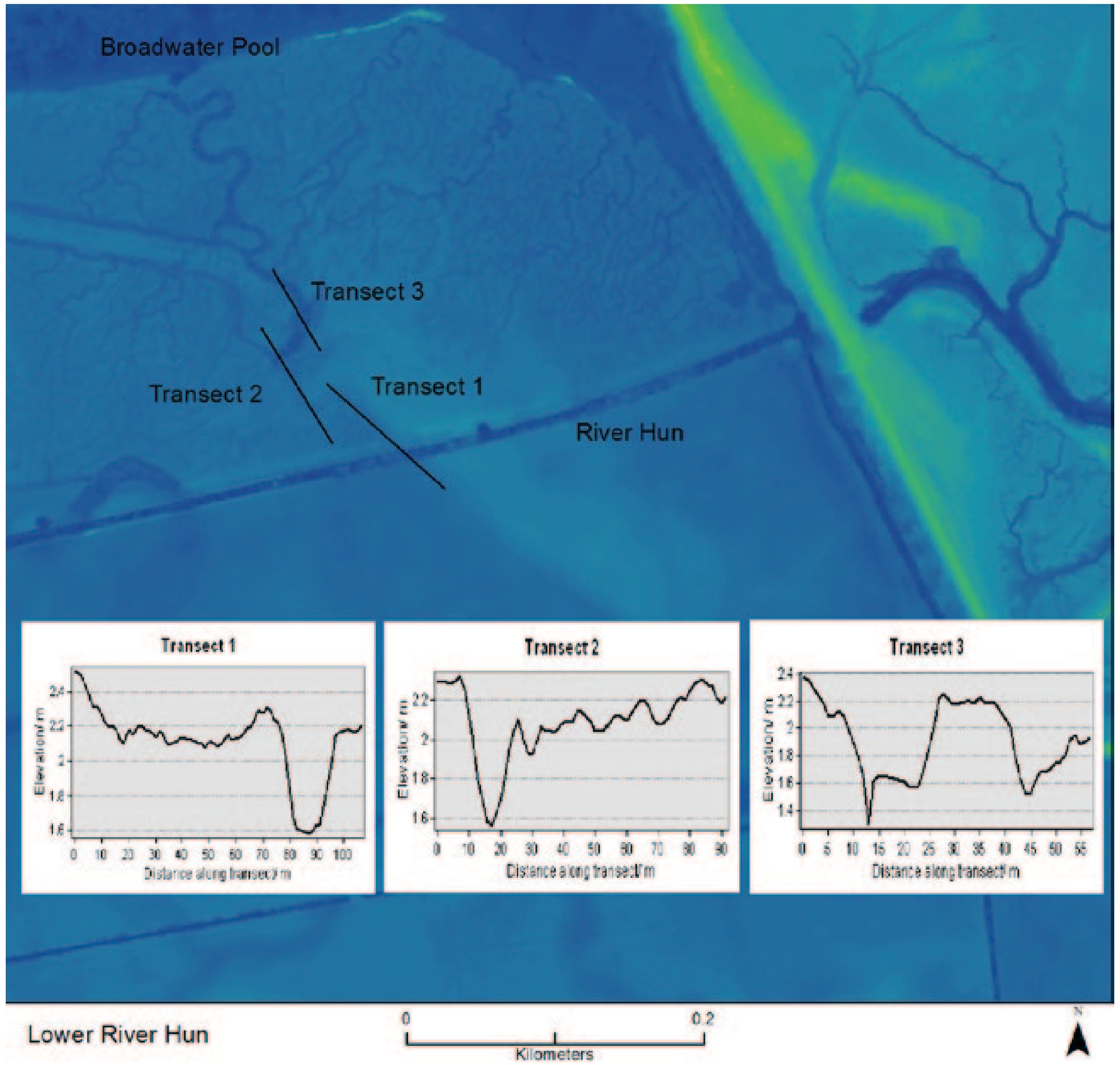


Figure 3. Elevation analysis of River Hun in Holme Nature Reserve to assess the feasibility of re-wetting historic tidal creeks to improve bird habitat. Green areas are of higher elevation and increasingly dark blue areas are lower. Cross sections are taken left-right looking downstream as is standard practice. The area pictured is about 290 metres upstream of the tidal sluice. Because the creeks under examination historically originated from the Broadwater side it can be seen that they are in fact of greatest elevation closer to the river and reduce in elevation as they approach Broadwater. As a result once water has reached the creeks from the river system it will easily flow to fill the rest of the creak system. Bunds to protect Broadwater from filling from the river would need to be checked. To fill the creeks as they stand, a 50-60 cm increase in water levels and removal of what appears to be a bund at the top of the creek system would be required. It may be that this increase in water levels would be excessive. In this case, some physical work to lower the bed of the first section of the creeks would to allow the water to flow into the rest of the system. This will mean that less of an increase in water levels would be needed.

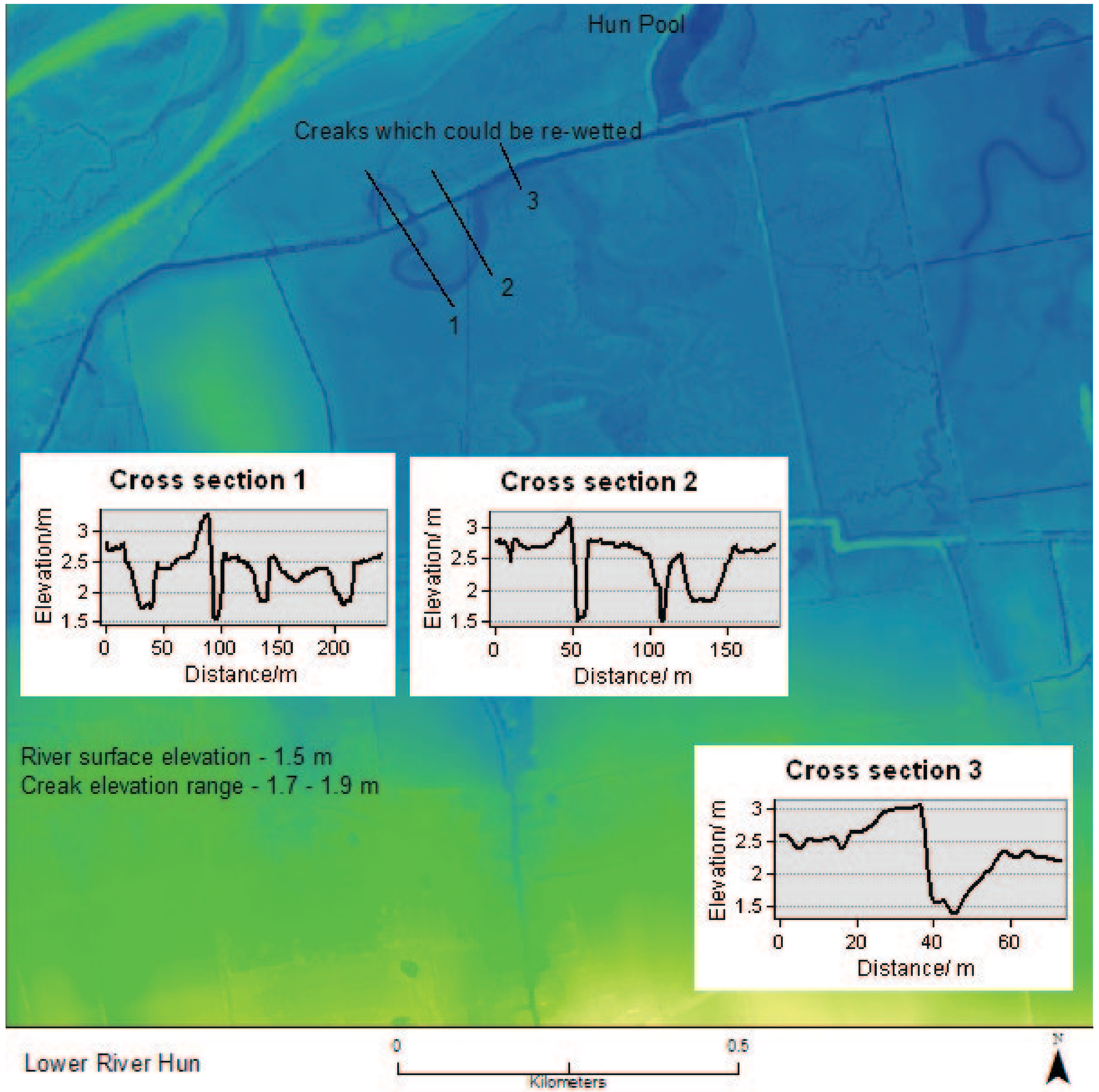


Figure 4. Elevation analysis of another area in the River Hun in Holme Nature Reserve. Green areas are of higher elevation and increasingly dark blue areas are lower. Cross sections are taken looking downstream as is standard practice. They show that river Hun is lower in elevation than the historic of the creeks by 0.2 – 0.5 metres.

COSTS AND TIMELINE

In the case of most rivers there would be a Water Framework Directive target set, and the Hun's progress would be judged against relatively rigorous biological, physical and chemical standards. Due to its short length and consequent low profile, the Hun is not given a status or objective under the Water Framework Directive. This means that this catchment plan has particular significance as a step in determining what objectives should be set.

As a result of centuries of modification, the lower sections of the river could benefit from measures which would increase the habitat quality, which is currently extremely poor. Increased cover, and a variety of in channel habitat in particular will need to be addressed.
Overall, the order of priorities for the river are as follows:

1. To improve public access and expand the wildlife corridor around the river between Old Hunstanton and Home next The Sea.
2. To enhance stream habitat in "Zone 1" by channel structure work and tree planting.
3. To restore the lower river ("Zone 2") to an estuarine salt marsh environment, or at least emulate some aspects of the natural landscape by re-flooding some of the tidal creeks. If an estuarine environment is fully restored this could have the twin benefits of reducing tidal flood risk and of restoring a very special area for wildlife to its full potential.

These measures need to be discussed and decided on by the community and other partners with an interest in the area so that a comprehensive package can be agreed. Thereafter, works measures need to be undertaken when funding becomes available.

Action	Number of kilometres / sites	Predicted cost	Achievable timeline	Responsibility / capability
Zone 1: Channel structure work	1.4 km	£16,832	Ongoing to 2021	Norfolk Rivers Trust (NRT)/ Environment Agency (EA)
Zone 1: Tree planting	190 trees	£ 900	Ongoing to 2021	Volunteers/ NRT/ / EA
Zone 1: Retreat of fencing back to 10 metres each side of the river	1.5 km	Gain of public ammenity and wildlife area, some reduction in farmland and golf course area.	When agreement reached, hopefully by 2016	Community, Local authority
Zone 1: Improvements to public footpath	1.5 km	Local authority to assess	2015	Local Authority
Wetland mosaic where opportunities arise between A149 Road Bridge and Beach Road Bridge	1.6 km	£6,057	2021	NRT/ Volunteers
Zone 2, Option 1: (Managed re-alignment and restoration of lower Hun to salt marsh).	1 large site (Similar to 200 ha)	Cost unknown and beyond the scope of this plan, but in order of £1 million. How-ever, could result in less maintenance of exposed sea defences, and reduced flooding risk.	2024	A partnership of the local community, local author-ity, EA, Natural England, NWT, NRT
Zone 2, Option 2: (Re-wetting of some tidal creeks). Hydrological modelling to determine viability of raising water levels in Holme Nature Reserve	1 site	£ 8, 000	When/if desirable to NWT	Norfolk Wildlife Trust (NWT) with experitise from NRT

*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
The North Norfolk Catchment Abstraction Management Strategy
Norfolk Wildlife Trust
River Rehabilitation for Eastern England Rivers
Environment Agency homepage
Introduction to the Water Framework Directive
The State of England's Chalk Rivers Report

Photograph: © Philip Ames

THE RIVER HUN A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

www.norfolkriverstrust.org

THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

The Norfolk Rivers Trust
Stody Hall Barns, Stody, Near Holt,
Norfolk NR24 2ED