Dedication to John Bracken

Professor John Bracken, in his role at Aquens in UCD, was a mentor to many fishery scientists and limnology students over the years and was instrumental in the monitoring and rehabilitation works completed in the 1990s on the Rye Water.

Intel and the Rye River

At Intel, we consider corporate responsibility an inseparable part of our business. While many companies in the electronics industry now outsource most of their manufacturing, we continue to design and manufacture the majority of our products in our own factories. As a result, we place a strong emphasis on driving environmental sustainability across our global operations. We continually strive to improve our operations and minimise our impact on the environment and vigilantly pursue new ways to reduce emissions and improve energy management through conservation, renewable energy, efficient building design, and other efforts.

Intel first made the decision to locate a manufacturing location in Leixlip, Co. Kildare in 1989 and today the Ireland campus comprises 350 acres, of which 150 acres are in industrial use, with the balance of 200 acres being comprised of a mixture of amenity, residential and agricultural areas.
Since first establishing operations at the Leixlip campus we have been aware of the rich biodiversity contained within parts of the site and also the significance of the Rye water and its Valley. We constantly consider our ecological footprint at the campus and the preservation and improvement of the river waters and its valley has been an important part of our voluntary environmental initiatives for many years.

Over the last number of years Intel has supported major revitalisation projects of the River Rye, working to preserve and enhance its natural habitat, and we have a long standing commitment to the monitoring of the river through the funding of detailed annual reports that provide extensive resources on the physical and environmental features of the Rye.

> *"As a global technology and business leader, we are committed to doing the right things, the right way. For Intel, corporate responsibility is simply good business"*
>
> **Paul Ottelini**
> **Intel President and Chief Executive Officer**

This detailed monitoring of the River Rye has reached an important milestone as we are now in the 20th year of reporting. To mark this occasion, and to share the wealth of unique information obtained through many years of monitoring, Intel is delighted to commission this special publication

'The Remarkable Rye'. The publication, compiled by Aquens at University College Dublin, is an important reflection on 20 years of invaluable data that has been provided by the river water and valley. Intel is delighted to share part of the Rye's story of the past 20 years and we are committed to the future preservation and enhancement of this beautiful and unique natural amenity.

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INTRODUCTION

The Rye Water like all rivers has been intimately linked to the inhabitants of its valley through time, from the water-powered mills of centuries past to the present technologically advanced computer age. The Rye Water is one of the important salmon spawning tributaries of the Liffey and has good angling stretches. In this publication we celebrate over a quarter of a century of investigations which have documented the river's aquatic life and tracked its water quality. The Rye Water is among the few rivers in the country which can boast such long-term records for a variety of aquatic life, thanks to the continued financial support and commitment of Intel Ireland Ltd.

Our limnological investigations have involved us sampling macroinvertebrates, fish and some water chemistry. Macroinvertebrates are small organisms without a backbone that are visible to the naked eye. These so called 'bugs' live on the bed of the river and include insect larvae, crustaceans, worms and snails. They are very important in maintaining the health of our rivers, and also in terms of fish diet. Furthermore, they themselves can be used as indicators of water quality. In fact the major part of our water quality assessments has been based on macroinvertebrate community analyses, described later in this publication. One special macroinvertebrate occurs in the Rye Water, the white clawed crayfish which is a protected species, and we present some insight into its life cycle and habits.

Our fish studies have tracked changes in trout and salmon populations with a particular focus on their responses to habitat enhancement work that was undertaken in 1994 on a 2.5km stretch of the Rye Water downstream of Sandfords Bridge. The findings of these investigations have been presented as commissioned annual limnological reports to Intel but they have also contributed to three doctoral studies in the School of Biology and Environmental Science, University College Dublin. Furthermore, many undergraduate and post-graduate students have participated in the fieldwork on the Rye Water over the years and they gained invaluable training that could not be easily provided within their university courses. For some such practical training has given them a definite edge at job interviews.

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We are delighted to have the opportunity, thanks to the financial support of Intel Ireland Ltd., to compile the findings of the last twenty years and present for the first time some of the emerging trends in the data. We have also included information on other plant and animal life associated with the Rye Water valley to give some sense of its wealth of wildlife representing surveys commissioned by Intel Ireland Ltd.

Finally, this publication presents a platform to explore future opportunities and challenges for those who cherish the Rye Waters.

Painting by Aoife Quinn
(Rye Valley with Intel Ireland in background)

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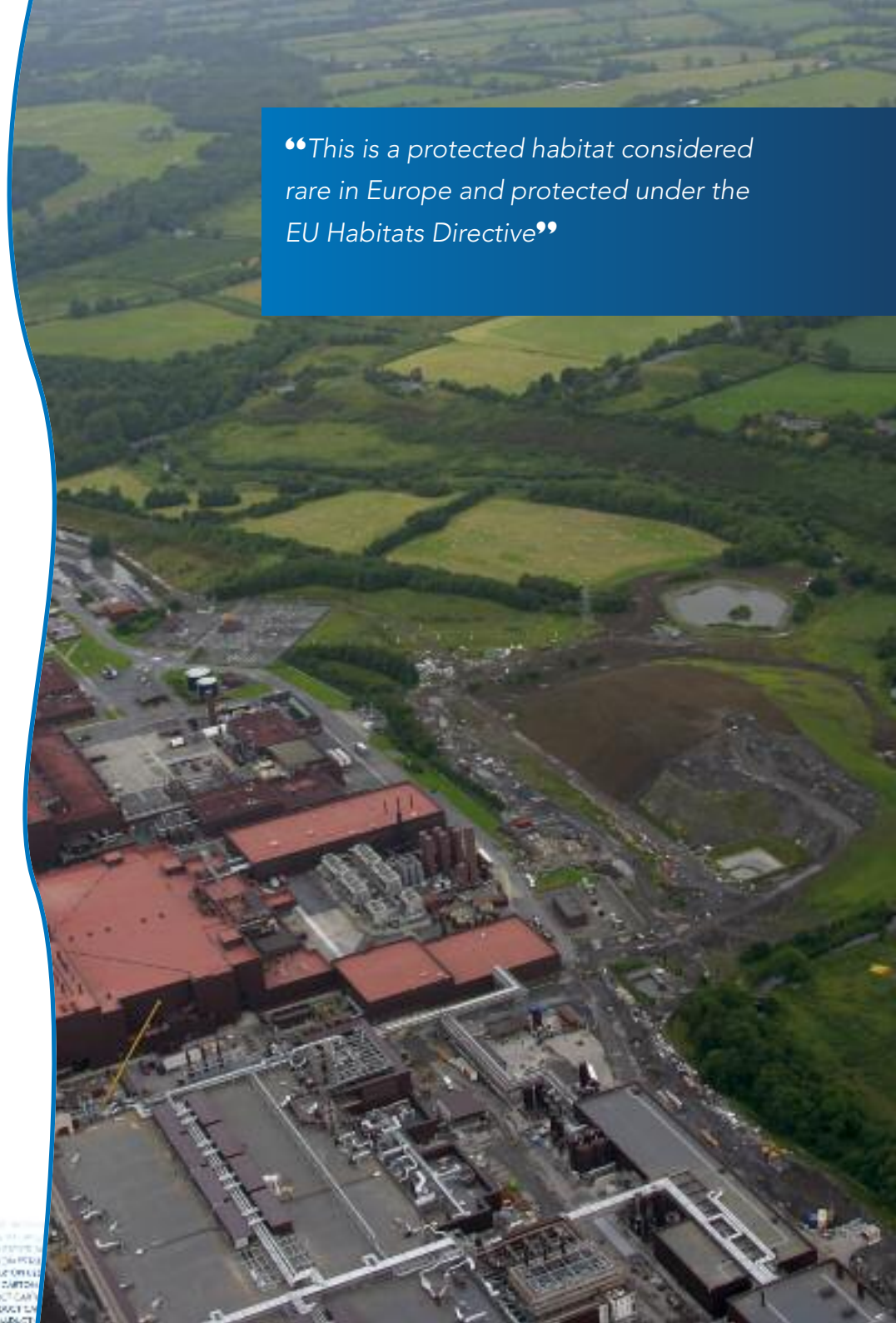
Aerial photo of a stretch of the Rye Water at the back of INTEL Ireland on which rehabilitation works were completed in 1994 to improve the riverine habitat for fish and other wildlife. The river channel was reconstructed after arterial drainage works in the 1980s and the collapse of the weir on Carton Estate which led to the siltation of a rather poor fisheries habitat.

Intel in the Rye Water valley

The Intel Ireland Campus located at Collinstown Industrial Park, Leixlip, is Intel's fourth largest manufacturing site. Over €6 billion has been invested in turning the 360 acre former stud farm into the most technologically advanced industrial location in Europe. From this viewing deck you can see the back of the Intel site which houses the main facilities for running the fabrication plants. The Rye Water runs at the back of the Intel campus, it is an important tributary of the River Liffey and is approximately 26km in length.

The Rye Water is considered one of the most important salmon spawning grounds in the Liffey catchment. A portion of the land surrounding the river is classified as a Special Area of Conservation. When Intel first located on the site the river was at risk due to large over growth of plants as a result of heavy silting which destroyed the natural fish habitat. Only a few salmon spawning beds had managed to survive the problems of silting and bankside erosion.

In 1994, Intel sponsored the major revitalisation of the Rye Water in order to re-establish Rye's potential as a natural salmon and trout habitat. Intel Ireland worked with the then Zoology Department in University College Dublin (AQUENS Ltd), Central Fisheries Board (now Inland Fisheries Ireland) and the Office of Public Works. As a result partnerships formed through the rejuvenation project and the 'Friends of the Rye River' group was established.



"This is a protected habitat considered rare in Europe and protected under the EU Habitats Directive"

Friends of the Rye

The Friends of the Rye River is a group of interested people who meet five times throughout the year to discuss the health of the river and plan areas for improvement. The group is made up of representatives from Intel, Leixlip District Angling Association, the Water Balif, the Central Fisheries Board, Kildare County Council, Ryevale Residents Association, Carton House, Zoology Department UCD and Leixlip Town Council.

Members of the Friends of the Rye River

Leixlip District Angling Association
As represented by Kevin McLaughlin

Ryevale Lawns Residents Association
As represented by Denis McCarthy

Inland Fisheries Ireland
As represented by Fergal Caffrey and Jim O'Brien

Kildare County Council
As represented by Gavin McDermott

Inland Fisheries Ireland
As represented by Fergal Caffrey and Jim O'Brien

Intel Ireland
As represented by Lisa Harlow, Sarah Sexton and Peter Dohert

Aquens Ltd.
As represented by Mary Kelly-Quinn, Roisin Lyons, Maria Callanan and Jan-Robert Baars

Leixlip Town Council
As represented by Paul Kelly and Shane Fitzgerald

Carton House
As represented by John Plummer

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Reflections of the Friends of the

Denis McCarthy

Ryevale Lawns Residents Association

Denis is the longest serving member to date of the Friends if the Rye River. Denis has also produced a report on the Rye Water and its source which has been very useful in providing information for the course of the Rye Water in this publication.

'I have seen many of the improvements initiated by Intel over the years, such as the pruning of trees along the Rye, the introduction of spawning beds (gravel) and the insertion of stones to create better water flow under the supervision of Dr. Martin O'Grady. The role of Kildare County Council has too been vital as they have played an important part in improving water quality by encouraging farmers to take precautions to prevent effluent entering the Rye.

Ryevale Lawns Residents Association has also made a big contribution to improving the amenity value of the Rye by creating walkways along the riverbank and undertaking a comprehensive tree and shrubbery planting programme on the hillside running down to the Rye'

Fergal Caffrey and Jim O'Brien

Inland Fisheries Ireland

Fergal is an Assistant Inspector with Inland Fisheries Ireland, formally the Eastern Regional Fisheries Board. Prior to Fergal's involvement in the annual surveys of the Rye Water at Intel, Jim 0'Brien had been involved since its inception in 1993.

Fergal is involved with habitat enhancement, fish stock assessment and the protection of trout and salmon on the Rye Water since 2002. He supervised habitat enhancement work undertaken by the OPW at Anne's Bridge in 2005 and is involved with the annual electrofishing survey operation funded by Intel and organised by AQUENS.
Jim was in of charge of the fieldworks and was also a member of the Friends of the Rye. For the annual electrofishing the staff of the Eastern Regional Fisheries Board were drawn on from their bases in both Carrickmacross and Virginia. This work could not have been undertaken without the assistance of the staff supervisors in those areas: the late Bill Reidy from CMX and Gerry Conaty from Virginia. Jim would like to highlight the numerous staff who have supported the project over the years and to mention the late John Bracken who he worked with on the Intel project since its inception. Jim would also like to mention and thank the Wynne family, neighbours of Intel's, who every year provide ease of access through their garden to the fisheries staff and their equipment

Gavin McDermot

Kildare County Council

Kildare County Council, having statutory responsibility for water management and protection within its jurisdiction, actively works on improving the quality of surface water and groundwater in the catchment of the Rye Water.

'The Council appreciates the importance of the Rye Water given that it is a major tributary of the River Liffey, a Special Area of Conservation and an important fishery habitat. Considerable resources have been dedicated to this work over the years and the Council has been represented on the Rye River Group since it was founded.

Investment in Water Services infrastructure has been significant in recent years with new sewage pumping stations constructed at Kilcock and Maynooth as part of the Lower Liffey Valley Sewerage Scheme. These facilities have replaced pumping stations that required upgrading as business and housing development increased in the towns'

Lisa Harlow

Intel Ireland

Intel played an instrumental role in the founding the Friends of the Rye and today continues to host the members on a regular basis. Lisa is External Relations Manager at Intel Ireland and has served in a variety of different roles at the Leixlip campus since Intel first came to Ireland. Lisa has been involved as a member for the Friends of the Rye for a number of years.

Four- spotted chaser *Libellula quadrimaculata*, this is one of the first dragonflies that can be seen one the banks of the Rye Water in summer

Chronology of Studies on the Rye Water

1983	A survey of the Rye Water catchment Area, first of the UCD studies.
1990	Initial baseline survey of the chemical and biological quality at four sites in compliance with planning for development at the Intel site.
1992	Survey extended to encompass additional sites upstream and downstream of the Intel site.
1992	First annual limnological monitoring of the Rye Water by UCD team commenced.
1993	An Intel supported fisheries enhancement plan is drawn up by Dr. Martin O'Grady (Inland Fisheries Ireland) in collaboration with Mr. John Curtin (OPW) and Prof. John Bracken (UCD).
1993	2nd Annual limnological monitoring.
1993	PhD study on the fisheries enhancement of the Rye Water. Completed in 1995.
1994	Fisheries enhancement programme carried out over a six week period in July and August.
1994	3rd Annual limnological monitoring.
1995	Leixlip and District Angling Association undertook a tree planting operation on the banks of the Rye Water in March.
1995	4th Annual limnological monitoring.
1996	5th Annual limnological monitoring.
1997	6th Annual limnological monitoring.
1997	PhD study evaluates the effects of the fisheries enhancement scheme on other biota of the Rye Water. Finished 1999.
1998	7th Annual limnological monitoring.
1998	Crayfish survey conducted as part of a PhD study.
1999	8th Annual limnological monitoring.
1999	Master's thesis on chemical and biological monitoring of the Rye Water.
2000-2005	Annual limnological monitoring continues.
2005	Further crayfish study on the Rye Water.
2006	Tracking the movement of trout in the Rye Water to assess the factors that influence fish movement, and an assessment of fish diet comparing salmon and trout.
2006-2012	Annual limnological monitoring continues.

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The Course of the Rye Water

The Rye Water rises in the flatlands west of Agher Cross, Co. Meath, approximately eight kilometres northwest of Kilcock, Co. Kildare. The source consists of a series of small streams which come from the flatlands and then join together to form the Rye Water. It follows an east-southeast course for 30.8 kilometres where it joins the River Liffey at Leixlip, Co. Kildare.

Covering a catchment of approximately 100km^2, the Rye water drains predominately agricultural land. The river flows through Carton Estate for approximately five kilometres where exists two artificial lakes created in the 1800s by the Duke of Leinster. A weir, bordering one of the artificial lakes, on the estate is thought to impede the upstream migration of salmonids on the Rye. The river continues south easterly under a series of bridges and through the lands adjacent to the Intel facility and flows under a bridge termed the Aqueduct which carries the Royal canal and a twin rail track.

The Rye water then flows along the Rye Valley and almost divides the town of Leixlip in two where it passes under the Rye Bridge, west of the main street, and then enters the River Liffey at the round boathouse under Leixlip castle which is only a few hundred metres downstream from the Leixlip hydroelectric dam. Although the river has been drained in parts in the pasts it is relatively fast flowing for most of its course.

Rye Water Valley/Carton SAC (site code 001398)

The Special Area of Conservation (SAC) lies along the River Rye between Leixlip and Maynooth. It has several rare and threatened plant and animal species that live amongst many common species.

Among these common species, exists many species of plants and trees. Trees found include the Yew *(Taxus baccata)*, Willow *(Salix spp.)*, Dogwood *(Cornus sp.)*, Ash *(Fraxinus excelsior)*, Elder *(Sambucus nigra)* Beech *(Fagus sylvatica)*, Oak *(Quercus spp.)*, Sycamore *(Acer pseudoplatanus)* and Hazel *(Corylus avellana)*.

The ground plants include species such as Golden Saxifrage *(Chrysosplenium oppostifolium)*, Meadowsweet *(Filipendula ulmaria)*, Common Valerian *(Valeriana officinalis)*, Marsh Thistle *(Cirsium palustre)* (top left), Wavy Bitter-cress *(Cardamine flexuosa)* and Bittersweet *(Solanum dulcamara)*, Ivy *(Hedera helix)*, Hedge Woundwort *(Stachys sylvatica)*, Wood Speedwell *(Veronica montana)*, Woodruff *(Galium odoratum)*, Wood Avens *(Geum urbanum)*, Common Dog- violet *(Viola riviniana)*, Wild Angelica *(Angelica sylvestris)*, Ramsons *(Allium ursinum)*, Ground-ivy *(Glechoma hederacea)*, Ivy Broomrape *(Orobanche hederae)*, and several orchids (like ?) (top right).

There are several species of protected plants present in this SAC which include Hairy St. John's-wort *(Hypericum hirsutum)* (bottom left), the Hairy Violet *(Viola hirta)* which has not been recorded recently, the Green Figwort *(Scrophularia umbros)* a Red Data Book listed species and the rare Myxommycete fungus *(Diderma deplanatum)*.

Marsh thistle
(Cirsium palustre)

Common spotted orchid
(Dactylorhiza fuchsii)

Hairy St. ohn's-wort
(Hypericum hirsutum)

Common field speedwell
(Veronica persica)

Mineral Spring,
Louisa Bridge

Marsh Lousewort
(Pedicularis palustris)

V. moulinsiana

White clawed Crayfish
(Austropotamobius pallipes)

Within the site there are also some special habitats that support diverse plant communities, in particular the mineral spring located at the Louisa Bridge (top left). This is a protected habitat considered rare in Europe and protected under the EU Habitats Directive (Annex I). It also has a Red Data Book protected species Blue Fleabane *(Erigeron acer)* associated with it which grows on the bridge. Other plants recorded here include Stoneworts, Arrowgrass *(Triglochin palustris)*, Purple Moor-grass *(Molinea caerulea)*, Sedges *(Carex spp.)*, Common Butterwort *(Pinguicula vulgaris)*, Marsh Lousewort *(Pedicularis palustris)* (top right), Grass-of-parnassus *(Parnassia palustris)* and Cuckooflower *(Cardamine pratensis)*.

Also found to occur near the Louisa Bridge in the marsh vegetation are the semi-aquatic snails Vertigo angustior and V. moulinsiana (bottom left) which are rare in Ireland and Europe and are listed in Annex II of the EU Habitats Directive. Also listed in Annex II are the white-clawed crayfish *(Austropotamobius pallipes)* (bottom right) and Salmon which spawns in the Rye Water. Another protected species is the Kingfisher which is listed in Annex I of the EU Birds Directive and is found among other birds such as the Blackcap, Woodcock and Long-eared Owl as well as the Little Grebe, Coot, Moorhen, Tufted Duck and Teal.

Habitats along the Rye Water

FOX DEER SANDFORD

Prior to the arrival of Intel the Rye Water valley was largely agricultural land dominated by grassland and hedgerows. The river had a lot of in-stream vegetation but had little riparian habitat with very few trees. As the lands were left to grow the hedgerows have matured (top left), the riparian habitat has grown since the planting of bankside trees (top right) and adjacent areas have formed semi-natural woodlands (bottom right). Areas were also planted with native trees including oak, hazel and birch which have now formed broad-leaved woodlands. The grasslands have also matured forming improved agricultural grasslands (GA1) (bottom left), that could be improved in future with limited grazing. As a result of the construction of Intel several urban habitats have also been formed including an artificial lake/pond (FL8), spoil and bare ground (ED2), and flower beds and borders (BC4) presenting further heterogeneity in the landscape.

Arterial Drainage in the Rye Water Catchment

MARSH MINERAL

The Rye Water drainage scheme, conducted to help improve agriculture in the Rye Water catchment area by providing increased land during the summer months, was completed in 1957 (John Murphy (OPW) pers. comm.). This scheme encompassed an area of 21,000 square hectares with 344 hectares of benefiting land. Of the main channel 24 km has had works conducted on it as well as 8km of its tributaries; this is relatively small in comparison to those conducted on other rivers, for example, the River Boyne has had drainage works carried out on 400km of the main channel and over 2,000km including tributaries. These works were run from above Kilcock to close to Leixlip town and are still maintained by the OPW in Newtown, Trim, Co. Meath. They are maintained on average between 1 to 7 years with the majority of works being conducted at Kilcock for the removal of silt (John Murphy OPW, pers. comm.).

Arterial Drainage in the Rye Water Catchment

A Retrospective of the Rye Water Fishery

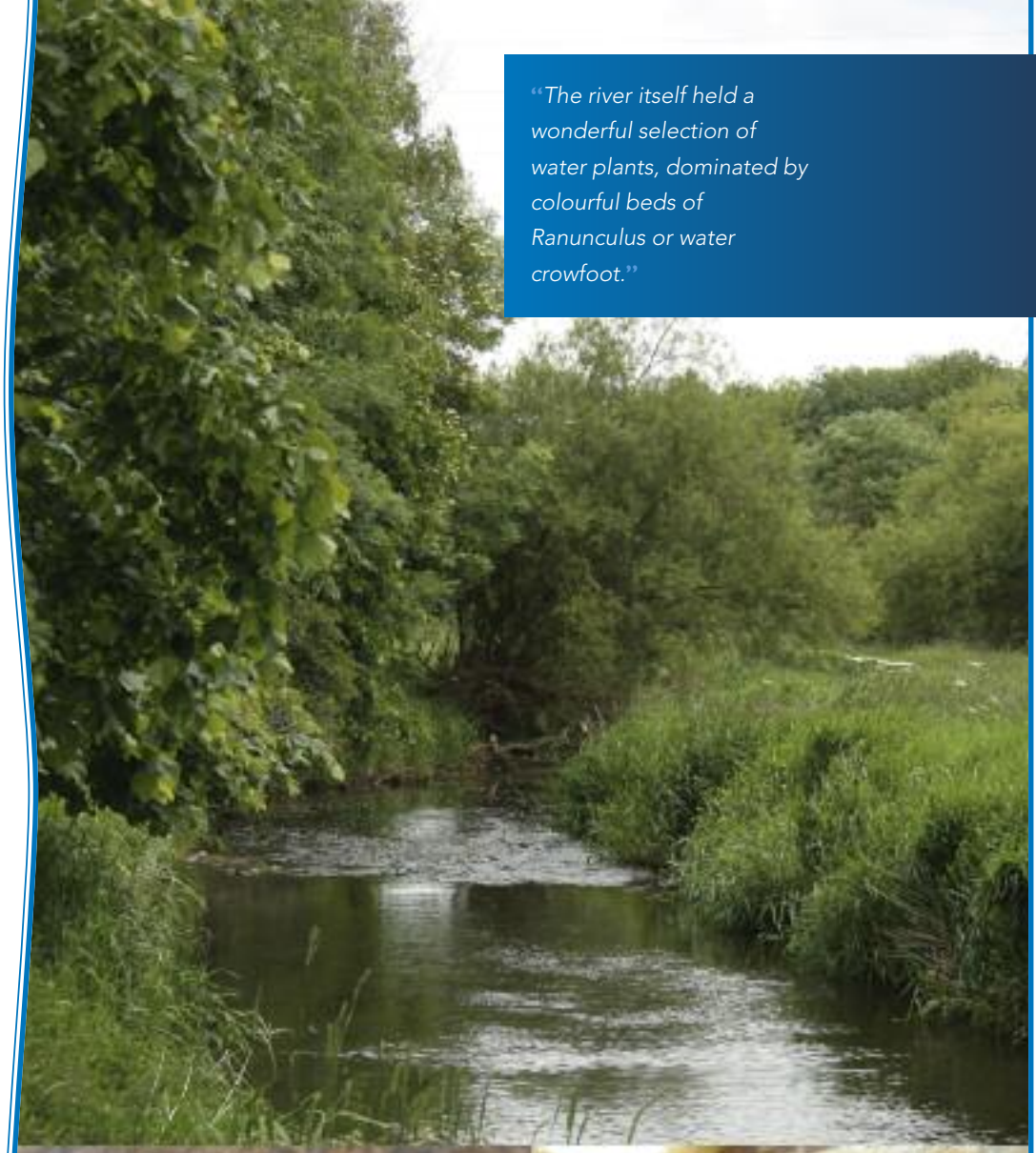
by Ken Whelan

For Dublin based trout anglers, particularly those interested in dry fly fishing, the Rye Water has always held a mystique and a very special challenge. Lying on a bed of soft carboniferous limestone the waters of this tiny stream are exceptionally rich and productive. The fauna and flora is typical not alone of the best of Irish limestone rivers but has many characteristics in common with the legendary chalk streams of the Wiltshire and Hampshire Downs in the south of England. As young, keen trout anglers in the 60's, the Rye Water provided my brother and I with unforgettable experiences in tackling these, at times, challenging waters. Our apprenticeship on the Rye Water allowed us to hone our dry fly fishing skills and prepared us for a fishing life tackling similar waters, stretching from the Balkans and Mongolia in the east to British Columbian in the west.

We lived on the south side of Dublin and access to the Rye Water involved a cycle to what was then Kingsbridge Station. Having locked our bikes to the railings at the station we headed off on the Number 66 bus to the Yellow House, just outside of Leixlip. The river had been drained in the past but had recovered well by the time we discovered it in the early 60s.

The river bed was a mixture of fine silt and polished gravel. The gravels were encrusted with a rich calcareous crud which crunched under foot as you waded upstream towards a pod of rising trout. The river itself held a wonderful selection of water plants, dominated by colourful beds of Ranunculus or water crowfoot. The broken rocks were covered in a dense mat of moss and the variety and density of insects and other invertebrates lurking amongst the mosses, plants and the stones was quite remarkable. Unlike many of its larger limestone cousins, which are often dour and difficult waters to fish until mid-May, the Rye Water fished well from early April, when hatches of the dark olive *(Baetis rhodani)* brought the trout to the surface. In late April and early May the river hosted hatches of one of the trout's favourite flies - the iron blue dun *(Baetis pumilus)*. Sheets of this small, dainty creature emerge synchronously in late April and early May, particularly on those bitter cold, late spring days which are often characterised by showers of sharp hail and biting winds. For an hour or so around mid-day the iron blues begin to hatch and trout throw all caution to the wind as they feast on these apparently delicious morsels. There is no real mayfly *(Ephemera danica)* hatch on the Rye Water but the intense hatches of blue winged olives *(Seratella ignita)* and a wide range of sedges (e.g. *Hydropsyche spp., Tinodes spp., Stenophylax spp*) throughout the summer and well into autumn more than make up for the lack of the mayfly.

"The river itself held a wonderful selection of water plants, dominated by colourful beds of Ranunculus or water crowfoot."



When we first fished the river our fishing was confined to a relatively short stretch from Yellow Walls (Sandford's) Bridge downstream to a few pools below the swimming hole. However, due to a serendipitous conversation at a family party, we learned that our aunt Mary had at one stage dated a Mr Lambert, who owned the land downstream of our original fishing area (where Intel Ireland is now located). A fairly scary and stern figure who kept all visitors off his land, my aunt's charm did the trick and we were given permission to fish what in essence at the time were virgin pools.

These pools were simply packed with the most beautiful, butter yellow wild brown trout. Short, broad on the back and pink fleshed, these were a wonderful prize. The average size was some 10oz (280g) to 12oz (340g) but every bag of five or six trout contained several fish between 1.25lb (560g) and 1.5lb (680g). Larger fish lurked in the deeper pools and our friend John Murphy had trout to his rod of 4lb to 5lb (2kg) in pools immediately below Carton Estate. My first salmon was also caught in the swimming pool – a story which I have recorded in my book The Angler in Ireland (1989).

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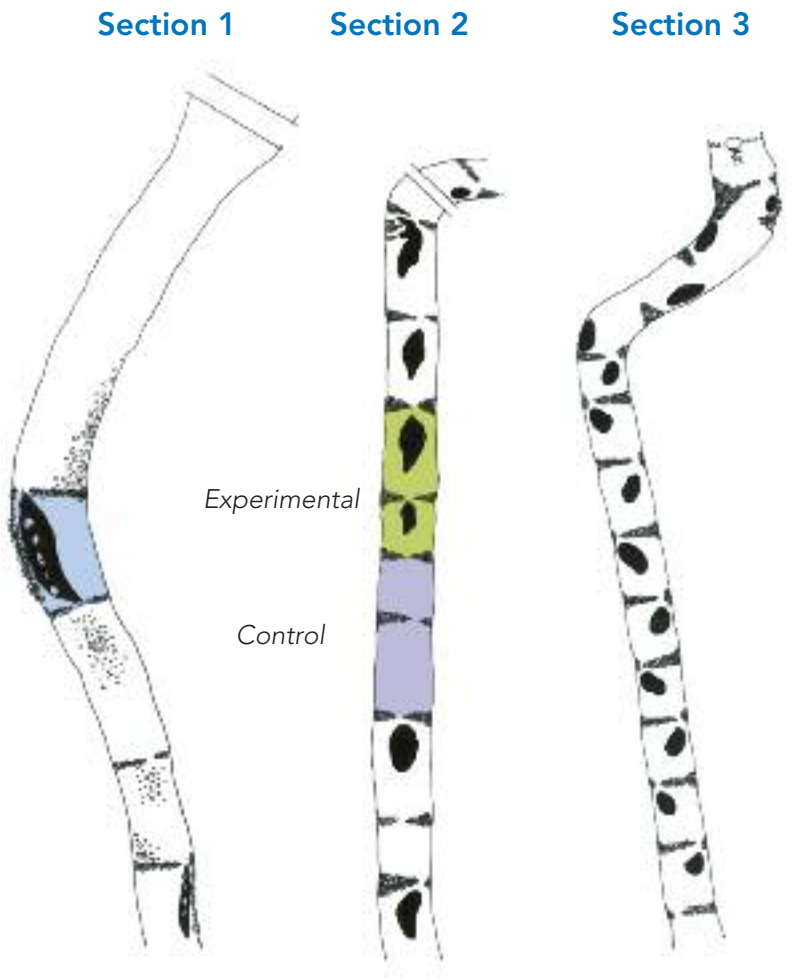
Hopefully this short description will give you the reader a flavour of the Rye Water of old and serve to set ambitious goals for the full restoration of one of Dublin's great natural treasures. Much has been done to restore its dignity since the river ran grey and polluted throughout years that followed those halcyon days of the 60's. But more still remains to be done if this unique river is to be fully restored for the enjoyment and pleasure of generations to come.

Fishery habitat enhancement programme benefits more than just fish

In 1994 a fisheries habitat enhancement programme was initiated by Dr Martin O'Grady, Inland Fisheries Ireland, in collaboration with the Office of Public Works and funded by Intel Ireland Ltd. on a 2.5km stretch of the Rye Water downstream of Sandford's Bridge. This stretch of the river had become shallow with hydraulically uniform glides and extensive in-stream growth of emergent vegetation (Photo on Page 25, conditions which are not conducive to good fish production. Consequently, there was inadequate pool depth for older trout and areas of spawning gravel were limited and generally heavily silted. Furthermore there was little bank-side, overhead cover for fish. The enhancement work involved considerable physical alteration of the river bed and banks. The objective was to increase water depth, improve spawning gravels and create more natural sinuous flow with adequate pool depth for older fish. Protection of the river banks from erosion and enhancement of the bank-side or riparian vegetation were also an integral part of the works.

Thirty two new pools were constructed and eight existing pools were enlarged. Spawning gravel was cleared of silt and random boulders were placed throughout the stretch to provide resting areas for fish. Three types of deflectors (single, paired and alternating) were constructed of rocks. The single deflectors were used to confine summer flow levels to a pool or river bend while the paired deflectors focussed the flow through a narrowed channel (bottom right) to encourage scour of the river bottom. The alternating deflectors created meandering or sinuous flow (top right). A number of V-weirs were constructed of rock to provide stable riffle and downstream pool habitat. Riprap was used to stabilise eroding banks but had the added benefit of providing cover for fish.

The enhancement works defined the three areas (Sections 1 to 3) for future monitoring. Within each there was a control (i.e. no in-stream improvement works) and experimental reach. The figures on the right illustrate the works undertaken in each monitored section. Single and double deflectors were installed in Section 1 and two pools were created, one of which was 20metres in length. Both were lined with rip-rap. Spawning gravel was located between the double deflectors. Limited work was carried out on Section 2 apart from the enhancement of existing weirs. This stretch was enhanced for fry production. Section 3 was the longest stretch at 600m and here several alternating deflectors were installed to create the desired sinuous flow with new pools between them, all providing good habitat for older trout and salmon.



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Before rehabilitation works

After rehabilitation works

The works are described in more detail in Kelly, F. (1996) Fisheries Enhancement of the Rye Water – a Tributary of the River Liffey. PhD Thesis, University College Dublin.

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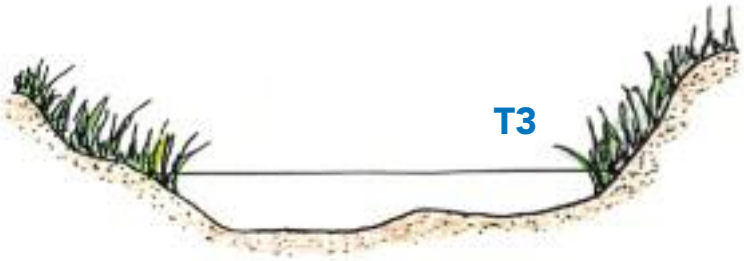
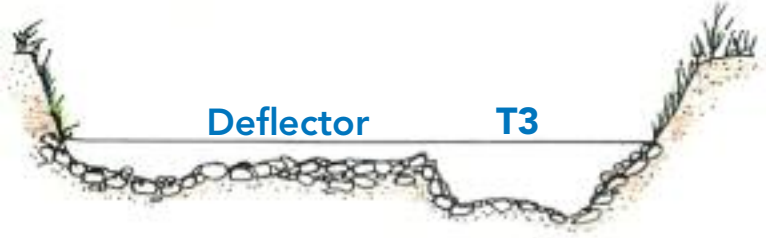
Sandford's bridge in 2012. The river channel is still open with in-stream vegetated areas and overhanging trees providing cover for fish. A large pool, constructed during original works, just below the bend still provides deep habitat for trout and salmon. The trees planted and riparian habitat has matured providing cover and food for invertebrates, birds and mammals, transforming agricultural lands to a haven for wildlife.

The broad-leaved woodland planted with oak, hazel and birch by Intel can be seen in the left of the picture.

Before enhancement works

After enhancement works





Salmonids

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Fish Species in the Rye Water

Brown trout *(Salmo trutta L.)* (top left) and salmon *(Salmo salar L.)* (top right) require relatively clean water to thrive, together with loose gravel beds in fast-flowing shallow rivers and streams in order to lay their eggs and reproduce successfully. The Rye Water provides suitable habitat for both species and the extensive rehabilitation in 1994 improved the habitat for the various life cycle stages.

Pike *(Esox lucius L.)* prefer sluggish rivers and streams with areas of dense vegetation but will inhabit any water body that contains fish and a few have been recorded in the Rye Water.

Similarly requiring gravel and fast flowing rivers is stoneloach *(Neomacheilus barbatulus)*

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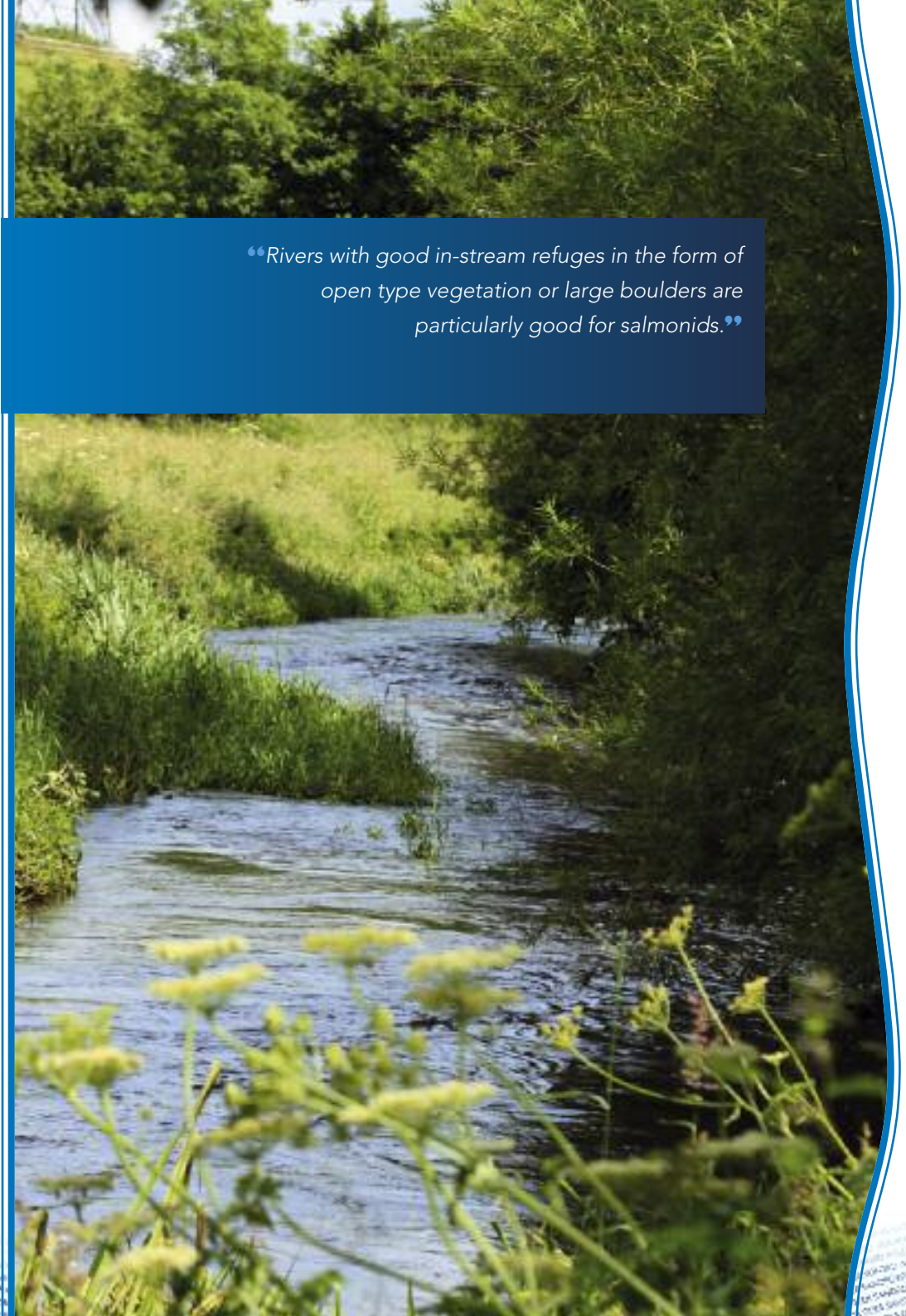
3-spined sticklebacks *(Gasterosteus aculeatus) commonly* known as 'pinkeens' in Ireland are found typically in well vegetated sites in the Rye Water that have muddy or sandy bottoms.

Rainbow trout *(Oncorhynchus mykiss L.)* are not commonly found in the Rye Water but are thought to inhabit similar conditions to that of brown trout, though they are more tolerant of warmer, poorer quality waters.

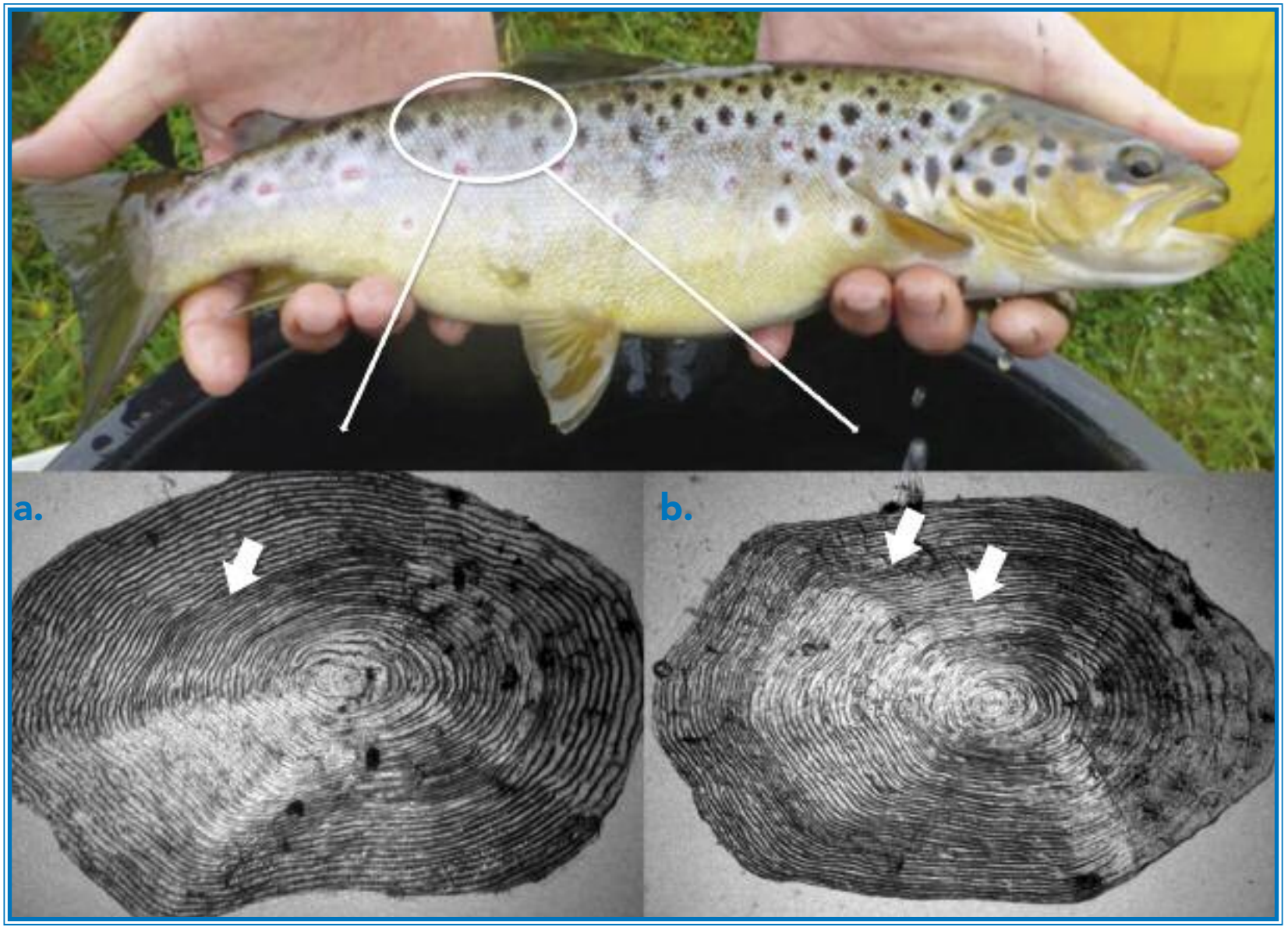


“Rivers with good in-stream refuges in the form of open type vegetation or large boulders are particularly good for salmonids.”

Fish Habitat Requirements

Salmonids require special habitats for their different life cycle stages; fry require fast flowing water and larger fish require deeper pools and runs. Rivers with good in-stream refuges in the form of open type vegetation *(Sparganium erectum* or *Ranunculus spp.)* or large boulders are particularly good for salmonids. The larger fish inhabit deep pools and undercut banks and tree roots that provide secure hiding places. The life cycle of brown trout and salmon are quite similar in the early years. Both deposit eggs into clean loose gravel beds during the winter months. The eggs remain in these gravel nests or redds, lodged between the small stones free of sediment, until the fry hatch. The redds can be easily distinguished amongst undisturbed gravels. Fry emerge during spring, and after initially living off the remaining egg they feed on small invertebrates. Some brown trout migrate to lakes, though many tend to remain in the river all their life. In contrast, salmon live for the first two years in the river and then migrate to sea as two year old fish. The salmon then return to their native river to spawn after a period at sea. Although they can occupy similar stretches the smaller salmon are usually found in the faster flowing sections (riffles and fast glides).

Salmonids are very opportunistic and largely feed on invertebrates that live in the water or become trapped on the water surface. Much of the diet comes from the adult stages of aquatic and terrestrial insects, like true flies. Only larger brown trout may feed on other small fish, such as minnows. Fish are most active during the warmer months of the year during which time they grow quickly. Like the rings of a tree, the rings on fish scales provide an indication of their age.



The concentric rings on the fish scale can be used to age the fish. Scales taken from a part of the fish that has little abrasion (area indicated on top picture) usually has well defined rings. Growth during cooler times of the year result in the rings clustering together as indicated by the arrows; a. >1 year old fish (1+), b. >2 year old fish (2+).

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VERSITY FISH COMMUNITY

Twenty Years of Fish Data

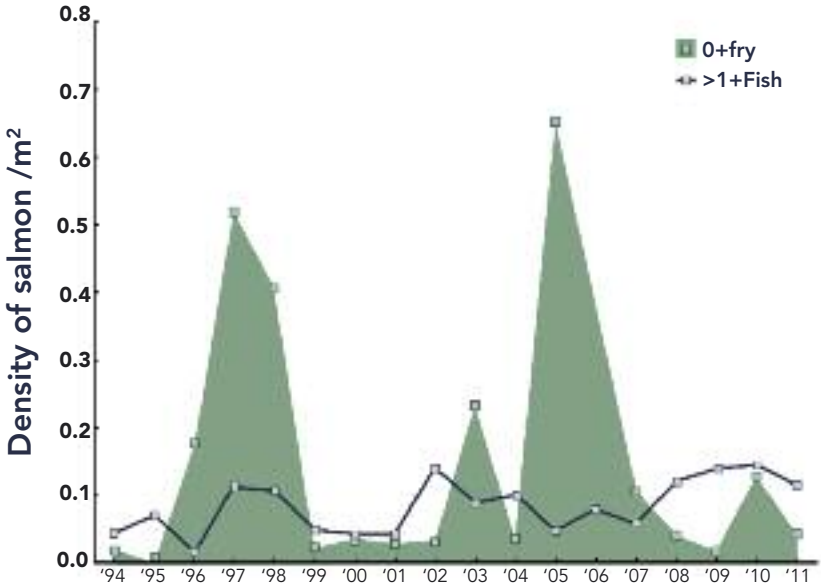
Electrofishing of the Rye Water was first conducted as part of the pre-rehabilitation phase of the original survey in July 1992 (Kelly, 1996). A 2.4km stretch of the river was electrofished qualitatively to determine the composition and distribution of the fish present before works began. A post-enhancement quantitative assessment of the fish population (as shown below) was then conducted between 1994 and 2006 over three stretches of the Rye Water located downstream of Sandford's Bridge.

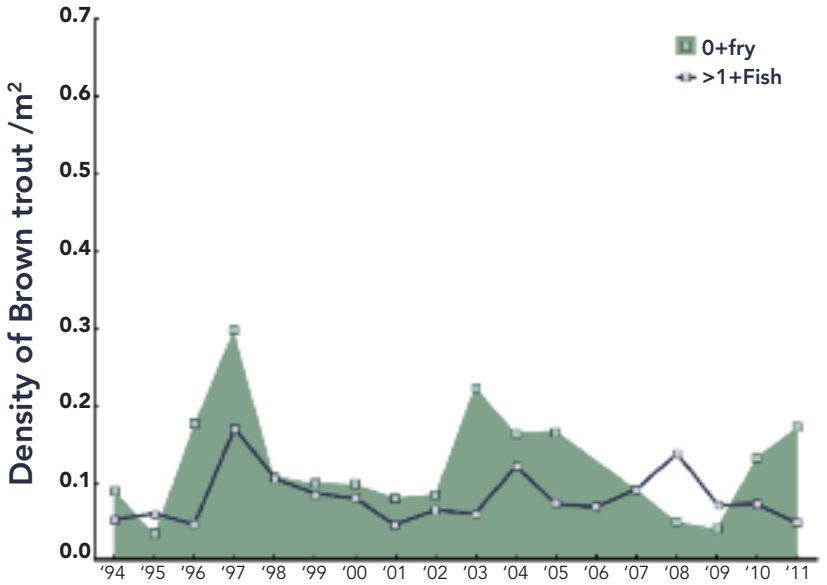
Nine sites in total, divided into control and experimental sections, were fished on an annual basis during this period. In 2007 the number surveyed was reduced to seven sites excluding the two sites above Stoneland Bridge. Thus, a significant proportion of the original sites surveyed in the years prior to this were retained providing a valuable long term dataset.

Trends in Salmonid Stocks

The Rye Water supports a healthy stock of both brown trout and salmon. The river is considered very productive and fish densities are relatively high. As with most fish, an abundance of eggs are produced by the adults to overcome the naturally low survival rates of the juvenile stages, like eggs and fry. Their survival is dependant on many factors including the environmental extremes that the eggs and fry experience. Factors such as low oxygen levels, high water temperatures, flood events, drought and heavy siltation can all affect the survival of these particularly vulnerable stages. The eggs and fry are also prey to many species such as the great diving beetle, damselfly larvae and larger species like birds, mink and older fish.

It is clear from our survey results, as presented in the graphs (right), that the numbers of fry in particular, fluctuate considerably from one year to the next with no discernable pattern. Salmon fry numbers reach very high densities from time to time, as indicated in the 1997/98 and 2005 surveys. The brown trout fry also peaked in some years but did not reach as high densities as the salmon fry. On average over the 17 year period trout fry were more abundant. The long term data show that despite the occasional high fry numbers of both salmon and trout the older fish population did not increase as a result. It rather appears that the 1+ fish (that should respond most to the previous year's fry numbers) remain relatively stable. This suggests that the fish population may have reached carrying capacity under the current environmental conditions. However, importantly the number of fry produced each year, seem to be enough to support the stocks at this carrying capacity.





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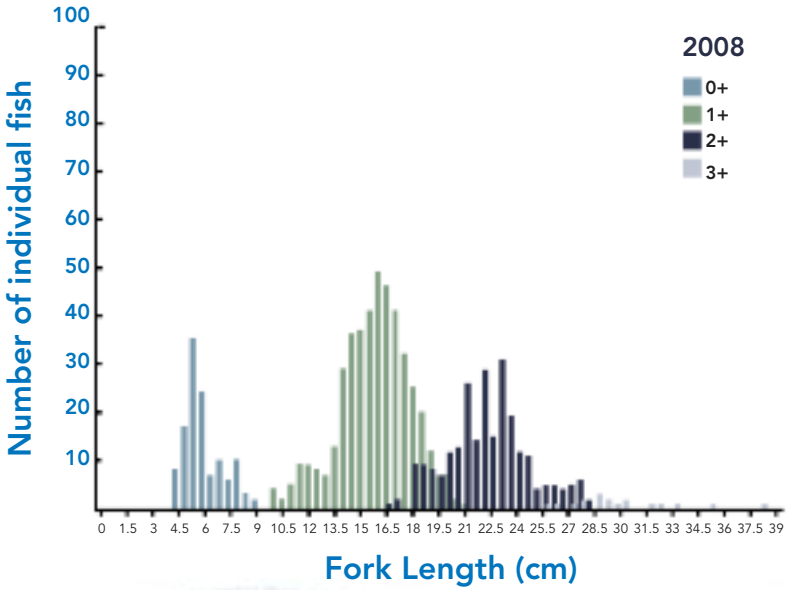
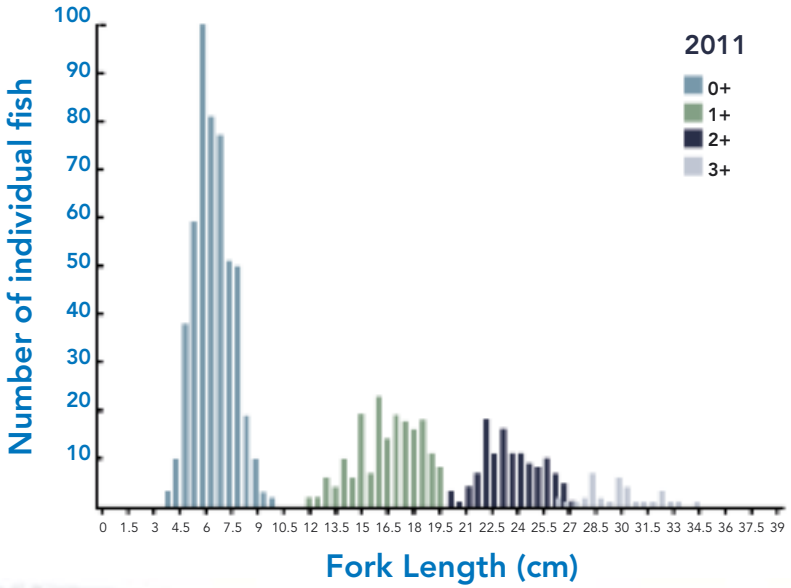
Brown Trout

The trout in the Rye Water are generally represented by four age classes. This includes the fry (0+) that have hatched early in the year and 1+, 2+ and 3+ fish. On some occasions 4+ fish are encountered, but these are generally exceptional. The proportion of fry fluctuates from year to year. In some years fry made up only a small proportion of all the fish (left below) and in others the fry dominated the population (right below). The older fish population structure is generally more stable with a higher number of 1+, fewer 2+ and fewer again 3+, i.e. 1+ > 2+ > 3+. While some of the variation in numbers can be attributed to the transient nature of salmonids, it is apparent nevertheless that overall abundances fluctuate from year to year. All the trout are usually in good condition and attain lengths about 10cm, 19cm, 27cm, and 33cm at 0+, 1+, 2+, and 3+, respectively. Fish attaining such lengths are indicative of a productive river where the conditions, such as water quality and food availability, supports fast growth.





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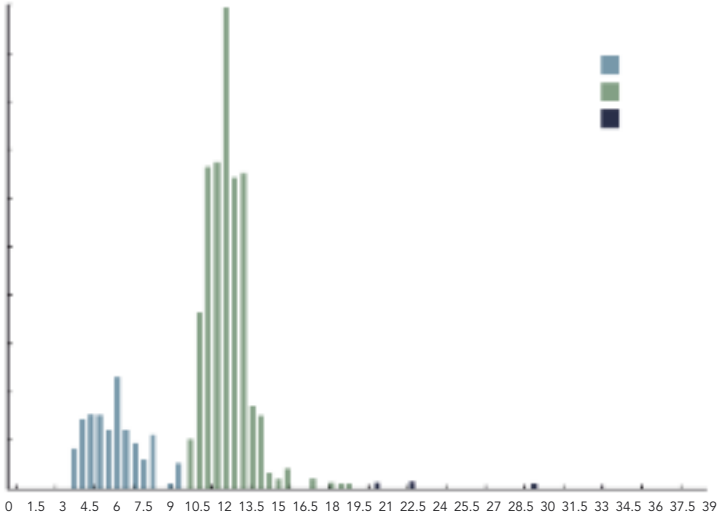
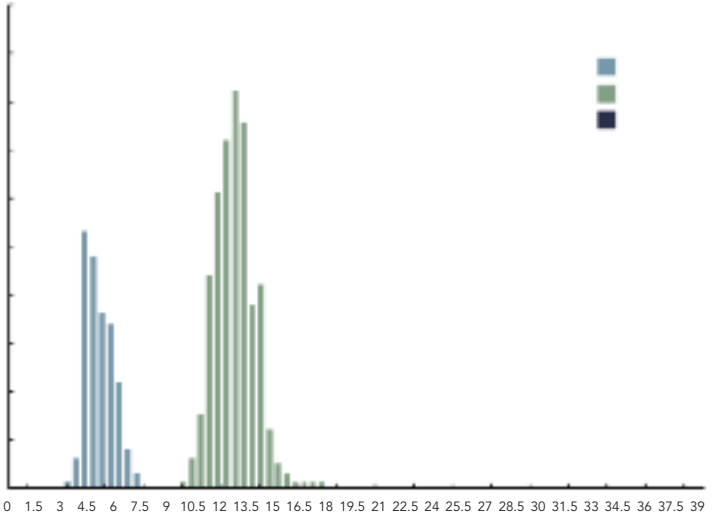
Salmonid

The salmon in the Rye Water, like most Irish rivers, consist of a smaller range of age classes depending on the time of year. Eggs usually hatch in January and the fry become progressively more noticeable later in the growing season. Fry surviving the first year persist as 1+ fish throughout the following year. Salmon usually remain in the river for only two years and then migrate to the sea as smolts in spring and early summer. Adult salmon then return to the river after a variable period of time in order to spawn and complete their life cycle. The timing of the salmon run is influenced by flood events but usually occurs in the autumn and the early winter months.

The survey results presented here are based on summer assessments, and indicate that the population at this time consists of fry and 1+ fish (graphs below). On occasion, a few smolts that still remain in the river are encountered. Due to the timing of the survey adult salmon are usually not captured, although on one occasion two adult salmon were caught in one of the large pools constructed during the rehabilitation works. Adult salmon can usually be seen in the larger pools during the winter months.





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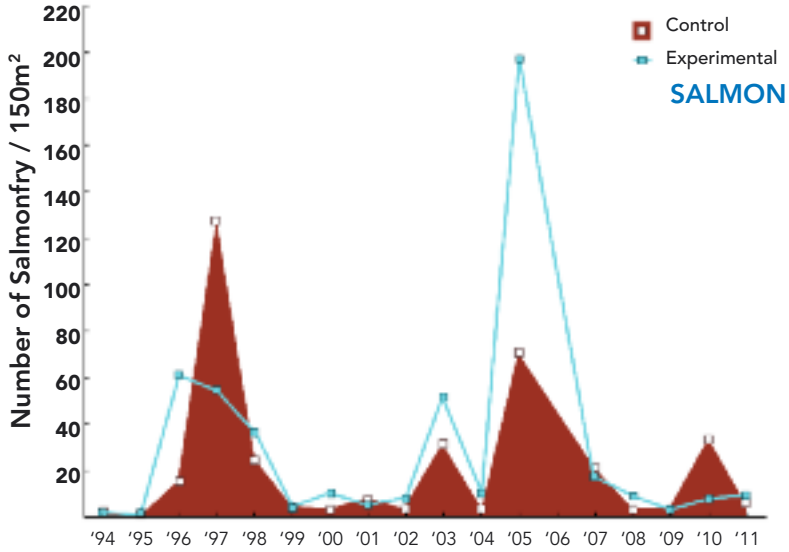
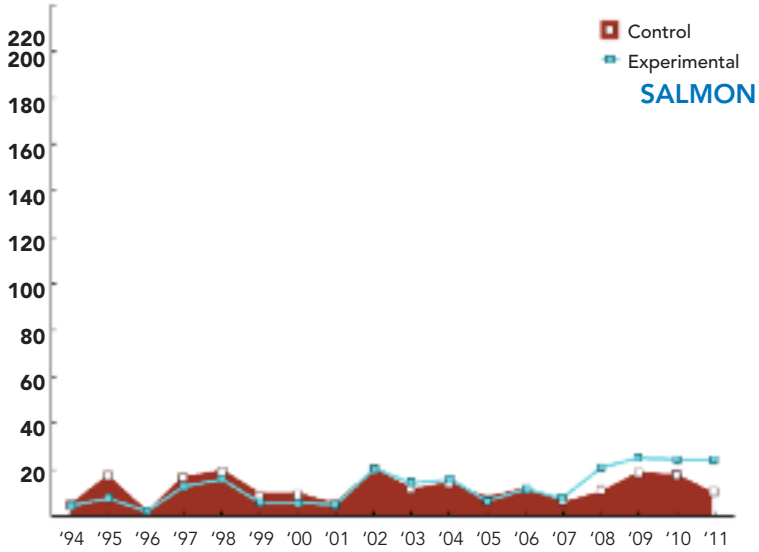
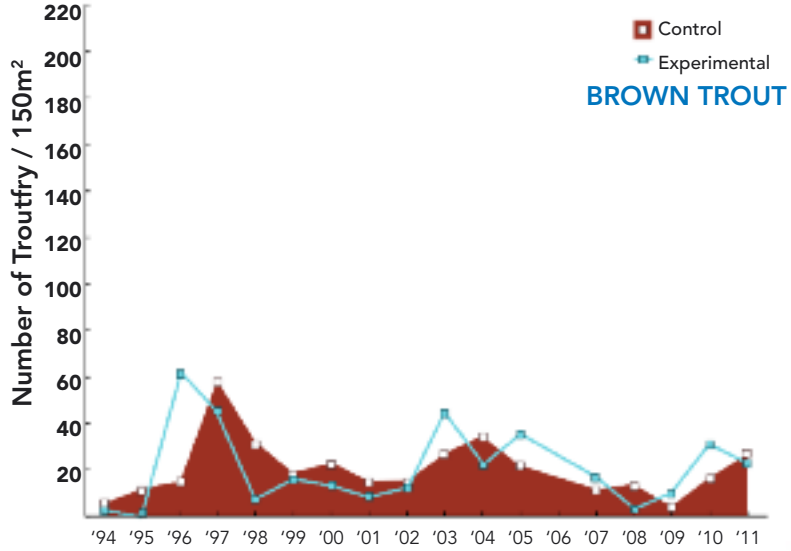
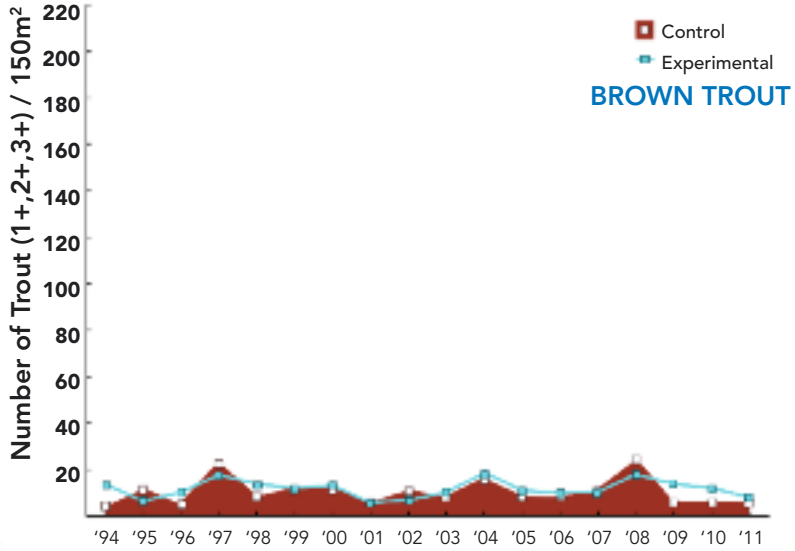
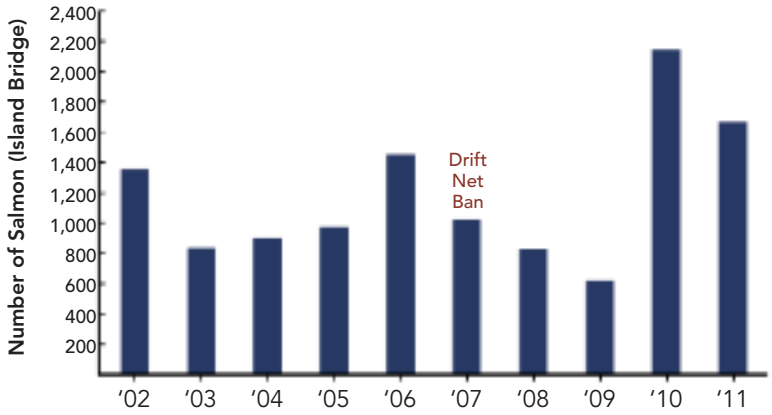
Control and experimental stretches were selected to assess how the salmonids would respond to the rehabilitation works. Most stretches were approximately 100m and represented several riffle-run-pool sequences. It is clear from the long-term trend results presented below that both the trout and salmon fry responded, rapidly increasing in density after the rehabilitation works. There are no clear differences between the control and experimental stretches as these contiguous stretches have been benefited from the changes made to the river habitat.



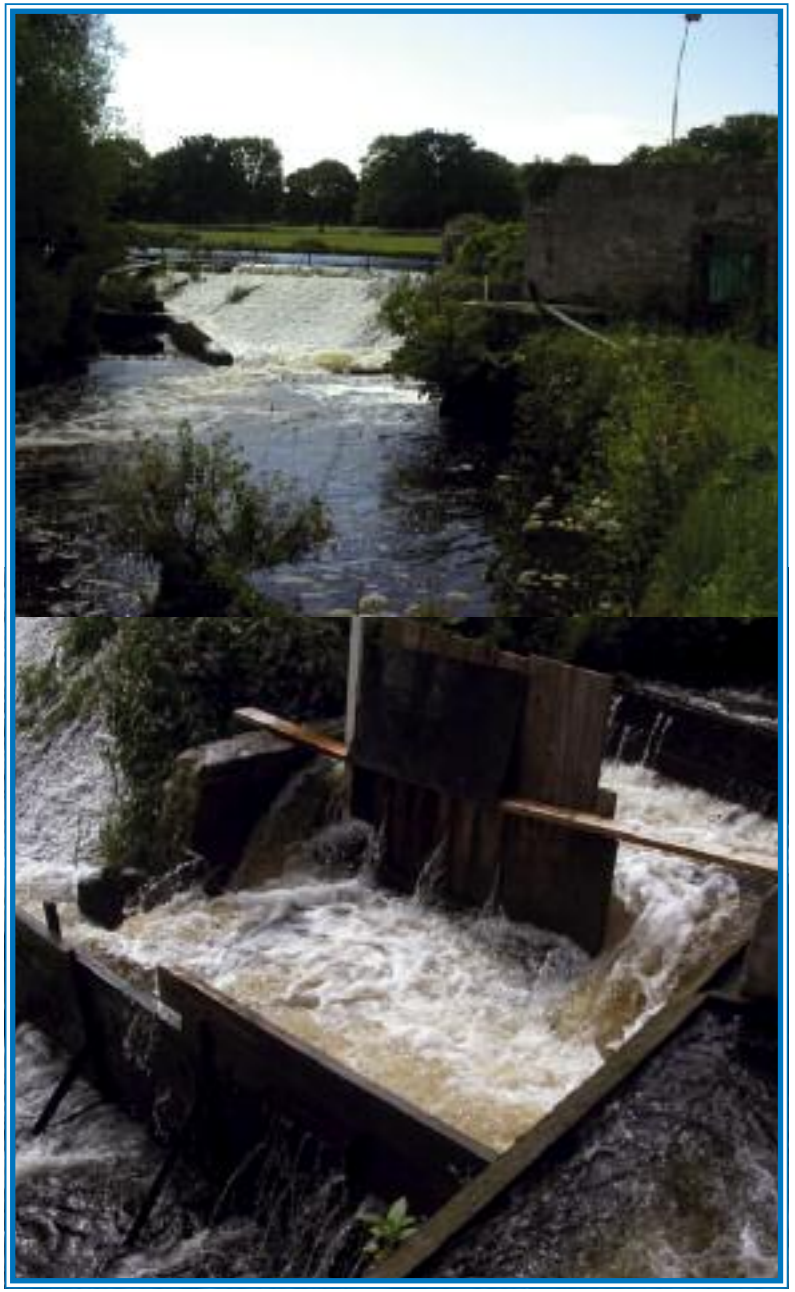








Counting station at Island Bridge (right above) managed by the Marine Institute. Fergal Caffrey (Inland Fisheries Ireland) (below) showing a salmon that returned to the Liffey and Rye Water catchment having come up the fish pass (right below) into a holding facility. There they are identified, counted and weighted before being released to continue their journey upstream. Salmon count since 2002 illustrated in the graph above.



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The dam wall (left) at the Leixlip Reservoir is a significant barrier to migrating salmon. Most salmon that come past the counting station in Island Bridge returning to the river catchment end up in the Rye Water. Most individuals enter the river from late summer into the winter months

Trout Movement

In the summer of 2002 and 2003 investigations of trout movement in the Rye Water were undertaken using radio-telemetry as part of a national study on the relationship between salmonids and water quality in Irish rivers. The work also contributed to the PhD thesis of Neasa McDonnell. Specifically, researchers aimed to determine whether trout moved to areas of the river with more favourable oxygen concentrations in response to pre-dawn oxygen sags which characterise this nutrient-enriched river. The oxygen profile was gained from data collected using a multi-probe installed initially at Sandford's Bridge but later moved to Rye Vale Lawns. Oxygen concentrations in 2003 were shown to drop as low as 6 mg/l O2 as early as midnight and continued falling until dawn.

Radio-tags weighing less than 2% of the fish's body weight (top right) were attached to ten trout in each year. Tracking commenced on 15th July 2002 and continued for five weeks. In 2003, tracking began slightly later on July 28th but also lasted for five weeks. Teams of volunteers tracked the fish between 4 and 7 am and from 1 to 4pm when oxygen concentrations were expected to be at their lowest and highest, respectively. Some additional observations were carried out throughout a number of 24-hours periods to capture diel activity. Oxygen concentrations were measured at all locations where tagged trout were released or captured.

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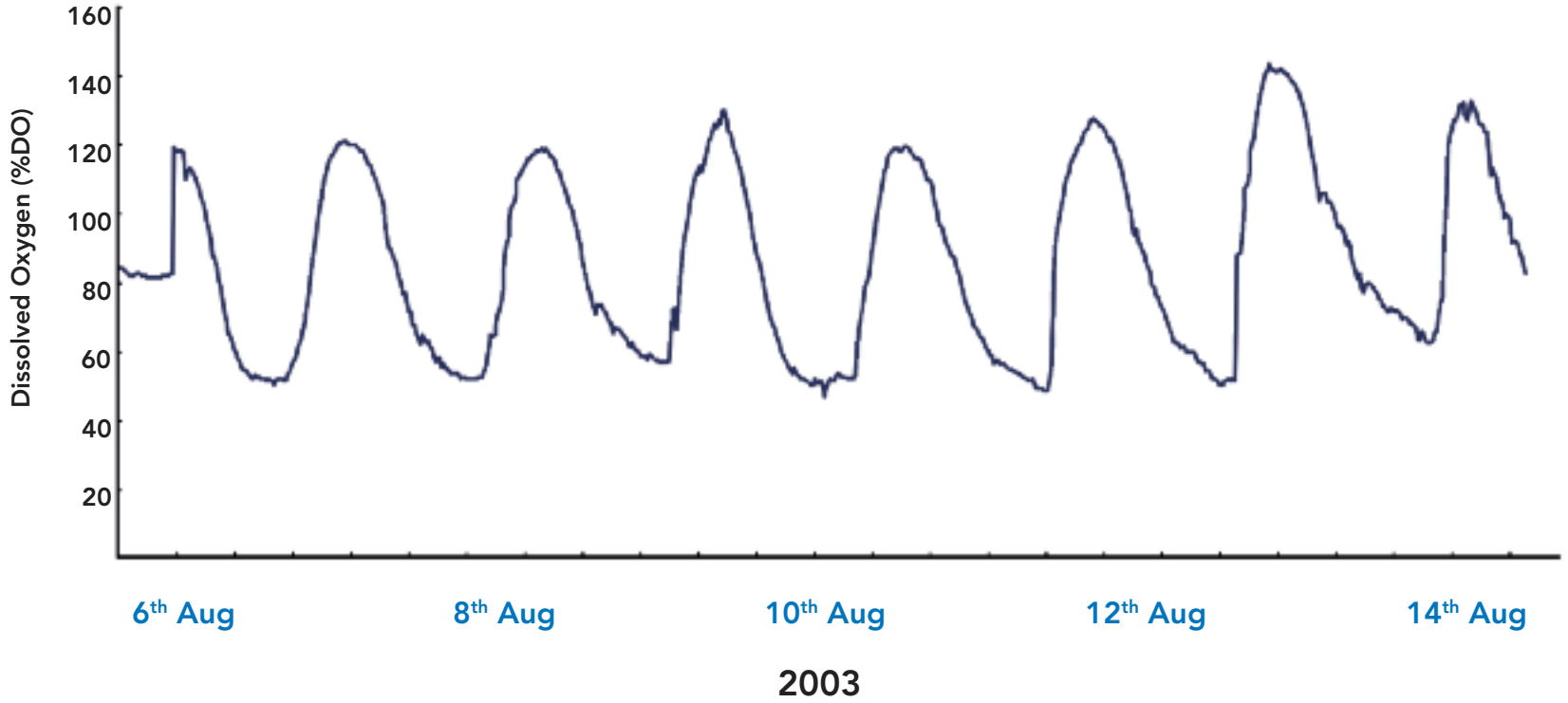
Some trout were lost to predation by mink (a tag was retrieved in mink scat). The results of the tracking showed two to three peaks in activity during the day (c.7.00-8.00, 11.00-12.00 and 21.00 to 23.00 hrs), probably corresponding to feeding forays. In 2002 all but two fish moved less than 10m between the two tracking periods. In 2003, most fish moved distances greater than 10m. Home range was calculated for each fish. The median home range in 2002 was 86m2 and was slightly larger in 2003 at 104m2, perhaps related to searches for more suitable habitat in response to higher water temperatures and lower oxygen concentrations in August 2003. However, movement did not seem to be related to oxygen conditions in the habitat the fish occupied. The fish used a combination of in-stream substrates, trees, reeds and roots for cover. In 2003, during a period of high water temperatures, trout were located in among stands of Phragmites sp. along the river bank. The reeds may have provided a refuge from predators during a period of oxygen (dropped to 4.35 mg/l O2) and temperature (21.750C) stress and allowed the fish to safely gasp for air at the surface of the water, commonly called surface respiration.



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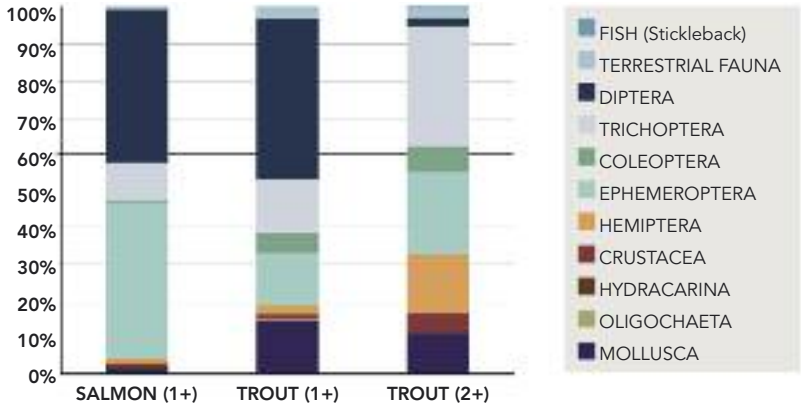
Trout eggs in the Rye Water

A study in trout egg survival was carried out over a six-week period from January to March in both 2002 and 2003. As before, this was part of the national study on the relationship between salmonids and water quality in Irish rivers. Eggs were stripped from trout at Cullion fish farm in Mullingar (right, top) and placed in vibert boxes interspersed with gravel (right, lower); these acted as artificial redds. Three clusters of six vibert boxes, were buried a depth of 10cm in the river bed, below Sandford's Bridge. Three boxes were lifted each week, and the numbers of surviving alevins (below) were counted. High egg mortality (>70%) was recorded in the Rye Water.

What salmon and trout feed on?

Salmonids are very opportunistic and feed on a wide range of organisms available to them. Their diet tends to change throughout their life, starting on microscopic aquatic organisms such as zooplankton and early life stages of macroinvertebrates. Trout and salmon are often seen feeding at the water surface where they prey upon insects emerging from the water or invertebrates that land on the water surface from the bankside vegetation. A large proportion of the fish's diet during the summer months is made up of organisms that originate from the terrestrial environment. When trout become large (2 years and older) they often feed on other fish like minnows and also crayfish.

A small study was conducted on the Rye Water in July 2006 to see what salmon and trout were feeding on. The results show that the diets of the two species were clearly different. Mayflies (Ephemeroptera) made up a higher proportion of the salmon diet whereas a larger proportion of snails (Mollusca) was found in the trout compared to the salmon. Trout also fed on a wider variety of species. There was also a notable difference in the diet of 1+ and 2+ trout. The older trout fed less on the flies (e.g. simuliids and chironomids) but fed more on the mayflies and caddis flies (Trichoptera). Although opportunistic the fish were selective and did not feed on all the available macroinvertebrates.

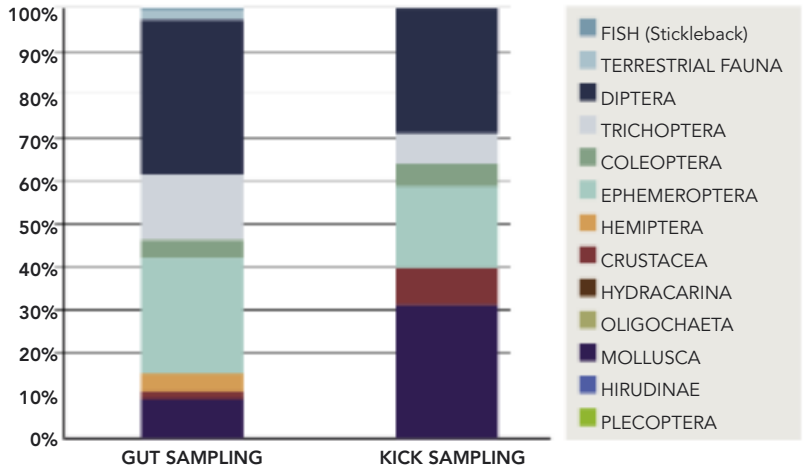


The proportional representation of the fish diet in salmon and trout in the Rye water in July 2006

Gut contents being flushed from the stomach of a brown trout using a small tube before being released, items shown include a variety of small aquatic and terrestrial invertebrates

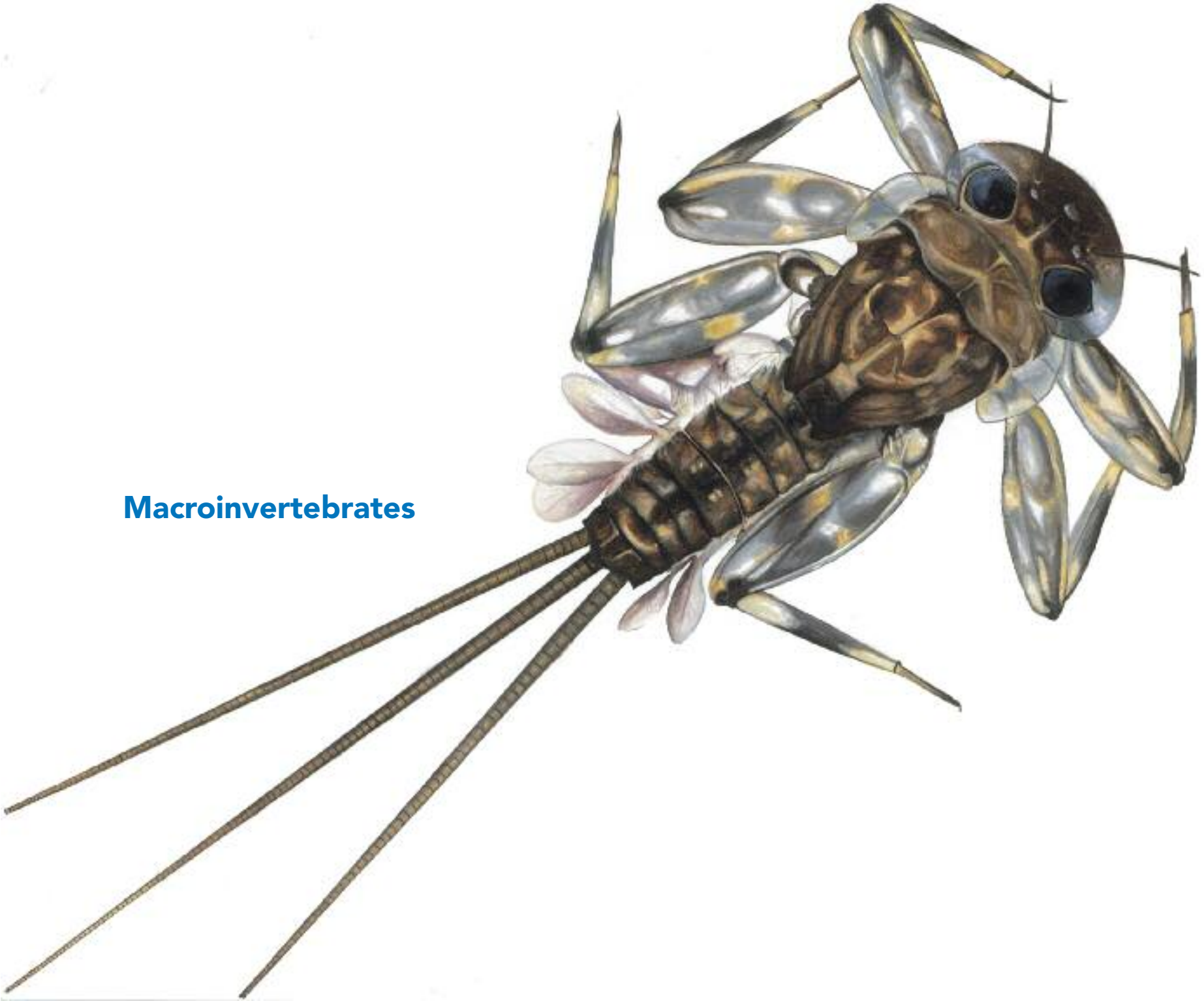
As these samples were taken during the fish survey in summer, the results only show how these species and ages differ on a single occasion. Studies have indicated that the gut contents of fish can be influenced by the time of day and recent weather conditions (e.g. recovery after flooding). As indicated fish are very opportunistic and also vary their diet according to what is available, so seasonal differences certainly occur. The results presented show how these fish differ but do not give an exhaustive account of their diet through the year. Therefore fishermen are best advised to stick to their favoured fly.

A comparison of fish gut contents and the macroinvertebrates found in the river taken using a kick net (above), indicating the selectivity of fish despite the availability of certain groups. A *Baetis rhodanii* nymph (below right), and *Ancylus fluviatilus* (below left) some of the more common invertebrates in the Rye Water.



A comparison of fish gut contents and the macroinvertebrates found in the river taken using a kick net (above), indicating the selectivity of fish despite the availability of certain groups. A *Baetis rhodanii* nymph (below), and *Ancylus fluviatilus* (below left) some of the more common invertebrates in the Rye Water.

Macroinvertebrates



What are Macroinvertebrates?

Macroinvertebrates are small organisms that live on the bottom of rivers and streams and are typically dominated by the larval stages of insects such as mayflies *(Ephemeroptera)*, stoneflies *(Plecoptera)*, caddisflies *(Trichoptera)*, beetles *(Coleoptera)* and a variety of fly *(Diptera)* species, in particular non-biting midges *(Chironomidae)*. Others include crustaceans such as the freshwater shrimp *(Gammarus sp.)*, waterhog louse *(Asellus aquaticus)* and our largest invertebrate, the white-clawed crayfish, as well as snails *(Mollusca)* and worm *(Annelida)* species.

Macroinvertebrates are important to the river ecosystem on several different levels and form an important aspect to the aquatic food chain. At the bottom of the chain we have the plant producers and in the case of the river system these exist through the leaf litter or in-stream vegetation such as algae, which are eaten by the macroinvertebrates. In turn the macroinvertebrates are a source of energy for larger animals such as fish and so on up the chain with many bird and mammal species finding homes in areas close to rivers and streams in order to feed on these fish and macroinvertebrates. The Rye Water is no exception to this and supports a variety of macroinvertebrate species which are particularly important to the salmonid fish communities in the river. Aquatic habitats are intricately linked to the surrounding terrestrial land as organisms from both habitats are interdependent. Many small invertebrates near rivers feed on the adult stages of aquatic organisms and these in turn provide food for those that live in the water. For example, a large proportion of a fish's diet is often made up of terrestrial insects that fall into the water.

"...a total of 103 different macroinvertebrate taxa have been recorded over the past twenty years..."

Macroinvertebrate Biodiversity in the Rye water

FOX DEEP SANDFORD

In the Rye Water macroinvertebrate diversity has been suppressed by persistent nutrient enrichment originating from a variety of point as well as diffuse sources. Despite this, and the fact that not all taxa were identified to species level, a total of 103 different macroinvertebrate taxa have been recorded over the past twenty years. The figure represents about 75% of the species that might be expected in this type of river. Macroinvertebrate biodiversity at any site has ranged between 25% and 50% of the total species compliment. The Lyreen has for most of this time supported the lowest taxon richness but has shown improvements in the last five years. Despite the pollution pressure 11 of our 33 mayfly species occur in the Rye Water, although the flat-bodies, pollution-sensitive species have a very patchy distribution. A fair diversity (23 species) of caddisfly larvae have been recorded, although this number would be expected to increase with improvement in water quality. Stonefly diversity has remained the lowest with just two species (Leuctra inermis and L. hippopus) recorded in fairly low numbers and at few sites. One might expect five other species to colonise the river if pollution pressures were reduced. Some improvement in beetle diversity would also be expected.

OWFOOT SILT ROCK MAYFLY

Macroinvertebrates and Water Quality

River-dwelling organisms have been used worldwide for over fifty years to detect water pollution and provide a measure of water quality. The term bioindicator is used to describe these organisms and among the most commonly used are macroinvertebrates. This is because they are the most numerous of the aquatic organisms in any stretch of river and the different species show varying tolerances to pollution, depending on its type and severity. For example most species of stonefly are eliminated by organic pollution whereas worms and leeches thrive under such conditions. Therefore, the composition of the whole macroinvertebrate community reflects the water quality for weeks or months prior to one taking a sample. In contrast, chemical analysis of water samples only provides a snap shot in time and is likely to miss intermittent or diffuse pollution events.

Here in Ireland, the Environmental Protection Agency employs a water quality scoring system in their river monitoring programme known as the Q-value (McGarrigle et al., 2002). This system has a five-point scale, Q1 (serious pollution or bad status) to Q5 (unpolluted or high status) based on the relative abundance of five categories of macroinvertebrates, from pollution sensitive to pollution tolerant. Intermediate Q-value classes (e.g. Q3-4 – moderate pollution/status) can also be assigned. We have used Q-values to report water quality on the Rye Water. We have also calculated another water quality index known as ASPT (Average Score Per Taxon), again based on the indicator potential of macroinvertebrates. An ASPT value >6 is generally indicative of good water quality.

Water Quality Trends in the Rye

Macroinvertebrate surveys were first carried out on the Rye Water in 1992. Three sites, Sandford's Bridge (Site 5), Stoneland Bridge (Site 7) and Upstream of the Aquaduct (Site 8) were initially used to assess the water quality prior to the restoration works, a further site on the Lyreen (Site 11) was added in 1994 immediately before the works started. These four sites were then assessed nine months after the works in 1995 and in 1996 two more sites were added to the survey, Kildare Bridge (Site 4) and below Kilcock (Site 2). The figure below show the water quality at the sites closest to the Intel site which have been monitored on an annual basis since 1996 and continue to be surveyed to this day on behalf of Intel Ireland.

Eutrophication and organic pollution are persistent problems in the Rye Water catchment, albeit that some improvements have occurred in recent years. Consequently, water quality has in general been slight to moderately polluted, while the Lyreen has been a consistent source of poor water quality that, fortunately, has not influenced the Rye Water water quality status as a result of dilution but is still of concern if further improvements are to be made in the Rye Water.

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The map above shows the locations of each of the 6 sites that have been monitored since 1996 as well as the Q-value ranges recorded at each. Three sites, Kildare Bridge, Stoneland Bridge and the Lyreen, have been selected to illustrate trends in Q-value and ASPT sine 1996.

The Kildare Bridge site has been rated Q3-4 for the last six years indicating moderate water quality, typical of eutrophication or nutrient enrichment, somewhat better than some of the previous years when Q-value fell to Q2-3 on two occasions. In contrast, the ASPT score has improved in recent years, from 4.3 in 2005 to a high of 5.9 in 2010 with only a slight drop to 5.7 in 2011. Sampling of this site only started in 1996 so there are no water quality ratings prior to the rehabilitation works.

The Stoneland Bridge (Site 7) site is closest to the Intel plant and is most similar in its macroinvertebrate composition to Sites 5 and 8, showing consistent results across the years. This site has maintained relatively similar ASPT scores over the 20 year period ranging from 4.8 to 6.1, with only one incident in 1992 when the score dropped below 5. In the last five years this site has consistently been rated Q3-4 and only recorded the lower value of Q3 on six occasions over the 20 year period.

The Lyreen (Site 11) site has received a Q3 rating since 2001. Although this represents a slight improvement on previous years it nevertheless indicates poor water quality. While Q-values have been stable in recent years, there has been an increase in ASPT scores, from 3.7 to 5.9. This may be due in part to improvements made to the physical habitat in 2009 which increased amounts of cobble and gravel substrates on the river bed.

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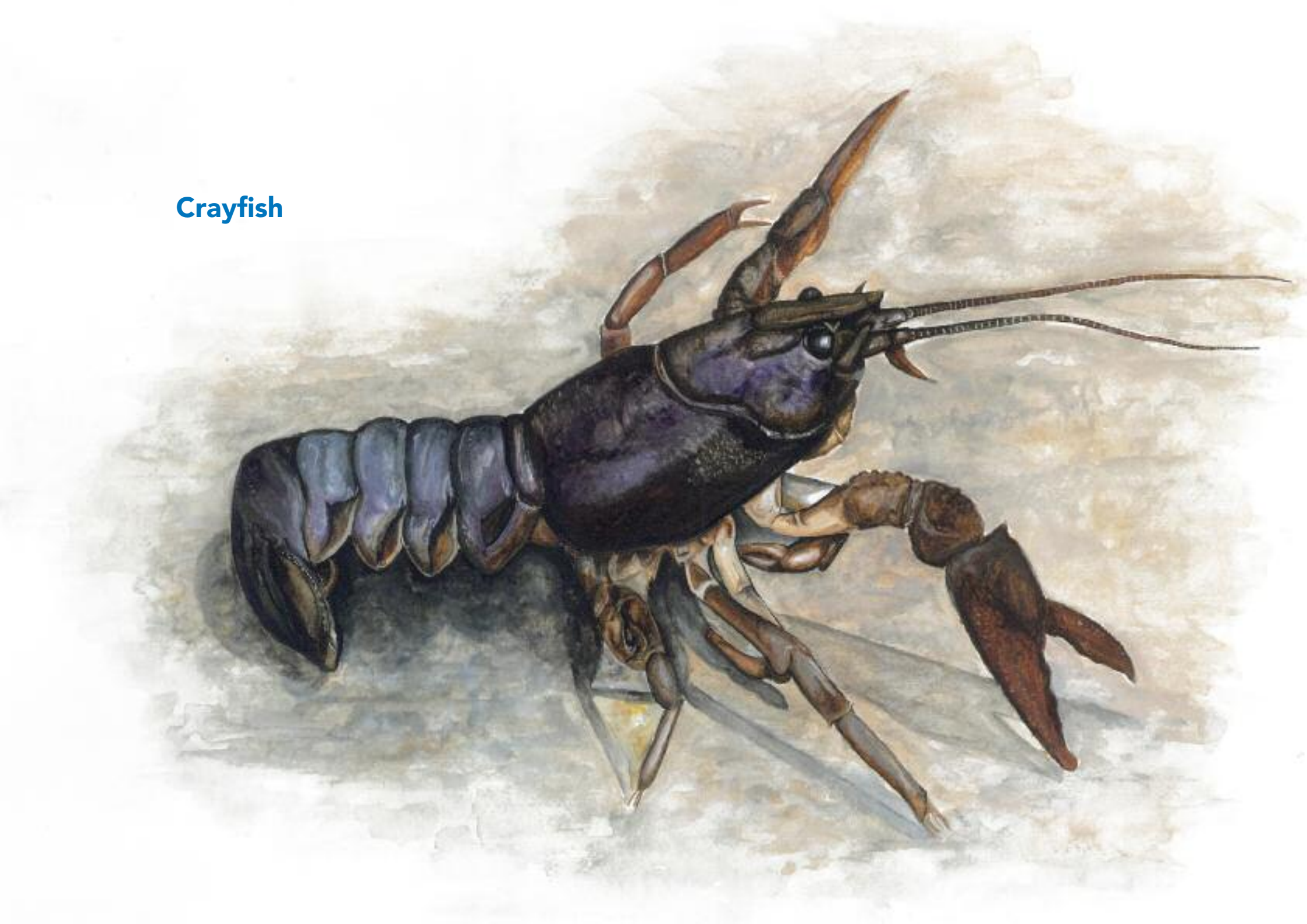
Crayfish



Background

The White-Clawed Crayfish Austropotamobius pallipes (L.) is one of Ireland's largest freshwater invertebrate, and although it's native status is under debate (Lucey, 1999) it is one of a few aquatic invertebrate species that is protected under Irish and EU Law (Annex II and V EU Habitats Directive 92/43/EEC). It occurs in both rivers and lakes in areas that are dominated by a lime-rich geology characteristic of the Irish midlands. Although widespread many populations are slowly declining (Demers et al., 2005; Reynolds, 2011), and there is some evidence that they have declined/disappeared from some lakes (Reynolds, 2011) and river catchments, emphasizing the need to conserve existing populations.

Crayfish are our largest freshwater invertebrate and should occur in most rivers and lakes in Ireland provided the calcium content is not too low and water quality is not severely impacted. Although the reason for the decline of crayfish in many water bodies throughout Europe over the last 20 years is unclear (Reynolds et al., 2010), reduced water quality or the occurrence of diseases, such as burn spot, porcelain disease or crayfish plague could be contributory factors. Crayfish can occur in reasonable densities and play an important role in aquatic ecosystems both as omnivores and as food for fish (trout and salmon), birds (herons) and mammals (otters) (Breathnach and Fairley 1993). Crayfish do particularly well in clean, calcareous aquatic habitats with an abundance of boulders and in-stream structures that provide cover or muddy banks which are suitable for their burrows. Aquatic vegetation both in and on the side of rivers can be a good refuge for both smaller adults and juveniles where food is usually plentiful and minimal flow provides ideal conditions.

Adult in water

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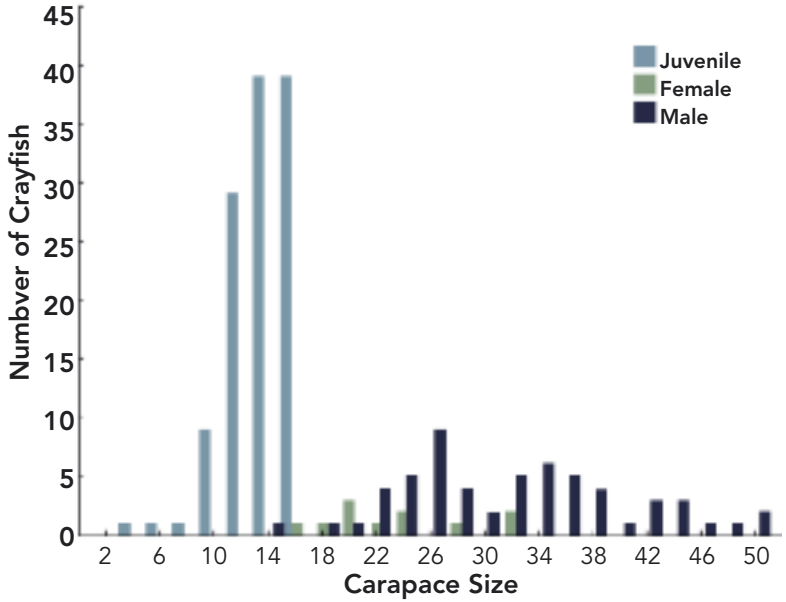
Surber sampler

Crayfish Surveys on the Rye Water

Although a frequent bye catch of both annual invertebrate and electrofishing surveys on the Rye Water, the white-clawed crayfish was assessed during two periods along a circa 2.5km stretch from Sandford's bridge to east of the Ryevale aqueduct. Surveys commissioned by Intel Ireland Ltd were completed in 1998/1999 and again in 2005, with an assessment of the adult population completed in both periods, while juveniles were assessed in 2005. Up to eight different sites were surveyed using baited traps (right) and large surber samplers to obtain a population estimate. As opportunistic feeders, the baited traps only attract adult crayfish living in the area, whereas the surber samplers provided an estimate of the juvenile densities per unit area. The adults and juveniles are usually spatially explicit as juveniles are often found amongst marginal vegetation where they can shelter from predators. Individuals collected were measured and weighted to characterize the population and assess their general condition, and then returned to the water.

State of the Population

The results of both time periods show that the crayfish populations in the Rye Water are healthy, and both adult and juveniles occur in reasonable numbers. The size profile of the individuals captured show that the recruitment of juveniles (<13mm) is good and that adults are of the size range usually encountered in such productive rivers (measuring up to 10.6cm). The graph of the size profile of the population (below) shows that adult males are usually larger than females, which are distinguished by the presence of two pairs of modified pleopods found on the underside of the first and second abdominal segments. Females adhere their developing eggs to the under side of their abdomens, which is most noticeable in early to mid summer (below right). The baited trapping (right) used in these studies usually results in a sex bias, i.e. greater number of males (Hogger, 1988), as is evident in the results presented from the 2005 survey (below).



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The 1998/1999 survey returned a large proportion of female adults, and juvenile densities of up to 9.2 individuals/m2 indicating that the population is healthy. As the rehabilitation works have resulted in significant changes to the river, the in-stream habitats varied over the length of the river. As a result crayfish populations were not equally distributed, as indicated by the total densities in the table (right). Adult and juvenile crayfish thrive in different parts of the river.

Crayfish diseases

The surveys showed that burn spot disease was present in the population but there was no evidence of porcelain disease or crayfish plague. Although of limited concern in the Rye Water Burn spot disease can cause significant mortalities, and is usually more prevalent in polluted waters. Although crayfish populations in catchments in the east, like the River Boyne, have been devastated by crayfish plague, the Rye Water seems to be clear of this fungus. Equivalent long-term studies on crayfish populations in the River Goul (a tributary of the Erkina) that became affected by the crayfish plague have still not recovered 10 years after populations were devastated. As fungal spores are easily transferred between water bodies, water users should be aware of this potential risk to the crayfish population in the Rye Water.

As another indicator of stress in crayfish populations, the degree of limb loss was assessed. Limbs can be regenerated after their loss, and the proportion of limb loss can increase when populations are under environmental stress. The populations in the Rye Water showed no signs of excessive limb loss.

Site on Rye Water	Size range (cm)	Total Crayfish Density (nos./m^2)
u/s Sandfords Bridge	3.8 to 45.0	0.8
Immediately d/s Sandfords Br.	10.0 to 49.0	2.4
~110m d/s Sandfords Br.	9.0 to 48.0	9.2
Immediately d/s Stoneland Br.	11.0 to 25.0	1.6
Immediately u/s large boulder	9.0 to 43.0	2
d/s large boulder	11.0 to 40.0	4.4
u/s Aqueduct	26.0 to 47.0	0.0
Ryevale d/s Aqueduct	11.0 to 37.0	1.2

Picture of limb loss and diseases

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Other Wildlife of Interest

The Annex II species of whorl snails Vertigo moulinsiana and V. angustior are both designated for protection in the SAC 000398 Rye Water Valley/Carton. Desmoulin's whorl snail Vertigo moulinsiana is known from both Louisa Bridge and the Carton Estate, and V. angustior from Louisa Bridge.

The general habitat in which Vertigo moulinsiana is present at Louisa Bridge is spring seepage and river flood plain. This is found in association with the Rye Water River but also in the important tufaceous spring and alkaline fen habitat further upslope.

Vertigo moulinsiana was first recorded at Louisa Bridge by Moorkens and A. Norris in 1995 (Moorkens, 1995). Baseline survey work in 2006 showed that the snail was present in low to moderate numbers, in a very small area, mostly in the marsh, mineral spring and seepage areas found on the slopes of the valley (Moorkens, 2007a). It was found to be in good condition during a further survey (Moorkens and Killeen, 2011).

Whorl snails Vertigo moulinsiana and V. angustior (By Evelyn Moorkens)

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The SAC is also designated for Vertigo angustior. The flood plain habitat at the base of the spring fed slope along the banks of the Rye Water, supports this species within the cSAC. This is an ecotone between marsh and humid meadow, flushing with saturated water rather than inundated by flooding.

V. angustior was first recorded at the site in 1933 (Kevan, 1933). It was later recorded in 1995 & 1997, which was part of the site selection process for SAC designation (Moorkens 1995, 1997). Later surveys in 2002 and 2009 did not record this species (Moorkens, 2007b; Moorkens and Killeen, 2011). The snail is vulnerable to changes in riparian and river management that can lead to increased flooding or drying of its habitat.

Birds

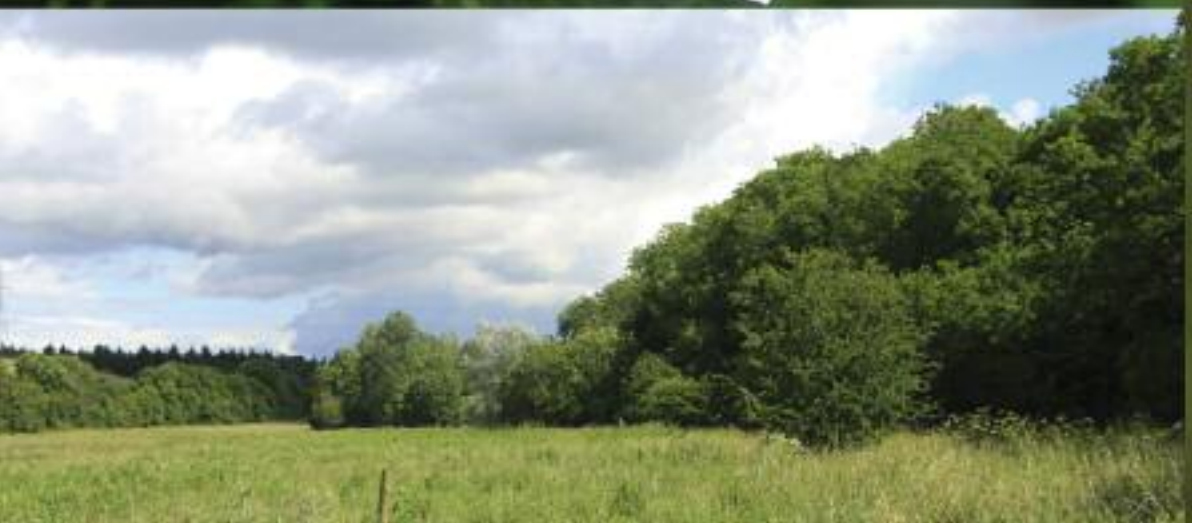
A survey of the bird life on the land adjacent to the Intel plant, that is a designated SAC, was conducted by Ní Lamhna and Collins in 2004 and recorded 47 bird species over a one-year period, of which 29 species were noted as breeding on the site. The species included the long-eared owl *Asio otus*, kingfisher *Alcedo atthis* (listed in Annex I of the EU Birds Directive), sparrow hawk *Accipiter nisus* and grey heron *Ardea cinerea* to name but a few. The full list of birds is included at the end of the publication. The presence of both the kingfisher and heron is a good sign of a healthy river ecosystem.

A later survey in 2010 (Flynn, 2010) found 30 species of which 19 were breeding. This survey involved only two summer visits and one winter visit compared to twenty-four site visits in 2004 which probably accounts for the lower species count. The authors were of the opinion that species such as the long-eared owl, buzzard and sparrow hawk were most likely present. Of special note is the record of an osprey on the Rye Water on 21st of May 2010 (Irishbirding.com).

The naturalness of the lands adjoining the Rye Water downstream of Sandford's Bridge and its variety of habitats and potential food sources probably accounts for this rich variety of bird life.

Mammals

Ní Lamhna and Collins (2004) and Flynn (2010) also surveyed the mammals on the Intel site. In 2004 eight species were recorded which included pygmy shrew *Sorex minutus*, fox *Vulpes vulpes*, badger *Meles meles*, fallow deer *Dama dama*, mountain hare *Lepus timidus* (Annex V), rabbit *Oryctolagus cuniculus*, grey squirrel *Sciurus caroliensis* and house mouse *Mus musculus*. In 2010 survey eight species were also noted of which three were new records. The three additional species included the brown rat *Rattus norvegicus*, stoat *Mustella ermine* and otter *Lutra lutra* (Annex II, Habitats Directive) bringing the total mammal count to 11 species.



Leixslip Spa

An important ecological and historical site, located on the Intel campus, Leixslip Spa is a unique area in Ireland, and as per current knowledge, possibly in Europe also. A mineral spring at Louisa Bridge, was historically diverted to what is essentially an outdoor, open-air bathing pool, known locally as the Leixslip Spa. The mineral spring is of conservation importance, and has contributed to the designation of the Rye Water Valley/Carton Special Area of Conservation. In 2011 Denyer Ecology was commissioned by Kildare County Council to undertake a bryophyte survey of the Leixlip Spa which is located to the south and north of the Rye Water at the Louisa Bridge, Leixlip. The results of this survey showed ninety-seven species recorded consisting of eighty-four mosses and thirteen liverworts (Denyer, 2011). This survey recorded no rare or scare bryophyte species but eight were new records for County Kildare.

For more information on the Leixslip Spa, visit
http://www.intel.ie/content/www/ie/en/environment/environment-leixlip-spa-story.html

Butterflies in the Rye Water Valley

Butterflies are a familiar part of our countryside and probably one of the most recognisable insect groups in the world. Like most insects each species has a particular flight period in the year and are best viewed on a sunny day when the adults actively fly. The immature stages of butterflies feed on plants and usually depend on a small number of plant species to complete their life cycle. The white butterflies *(Pieridae)* are particularly fond of plants that belong to the Brassicaceae and as a result usually occur where these types of plants are plentiful. Thankfully the small tortoiseshell (right above) and peacock (right below) feed on nettles and are therefore some of our most commonly encountered butterflies.

In grassy habitats the two most common butterflies include the meadow brown and ringlet (left) which are abundant in the grasslands in the Rye Water valley. Two species of butterflies, the red admiral (left below) and painted lady are migratory and are usually only found in Ireland when conditions are right for them to migrate from parts of southern Europe and North Africa.

List of Butterflies recorded

Small tortoiseshell	*Aglais urtica*
Meadow brown	*Maniola jurtina*
Small white	*Pieris rapae*
Green veined white	*Pieris napi*
Small copper	*Lycaena phlaeas*
Speckled wood	*Pararge aegera*
Orange tip	*Anthocaris cardamines*
Large white	*Pieris brassicae*
Red admiral	*Vanessa atalanta*
Painted lady	*Vanessa cardui*
Ringlet	*Aphantopus hyperantus*
Peacock	*Inachis io*

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A Vision for the Future

A river network like the capillaries of our bodies captures the health of its catchment. The Rye Water has been variably impacted by human activities over the last century and more so in recent decades. While the direct discharges that caused fish kills highlighted serious pollution problems that were clearly visible to all, the more insidious nature of diffuse nutrient pollution of recent decades had, and indeed continues to have the potential to cause the slow death of the river without most of us noticing. Thankfully due in part to the resilience of nature and also the efforts of those who care for the river, the Rye Water has maintained good stocks of fish and a reasonably diverse community of other aquatic and riparian organisms.

There are however opportunities to further enhance the river in the future. Implementation of the Water Framework Directive has the potential to move the river through the current impasse in water quality to at least good status (Q4). Our vision for the Rye Water has a higher target that sees the river attain its full potential as a nursery water for the endangered Atlantic salmon, a refuge for other protected species and as a trout fishery, as well as habitat for a wide diversity of other aquatic organisms. It is only when all components of an ecosystem have recovered that it becomes truly self sustaining with sufficient resistance and resilience to occasional pressures, be they natural or man-made. We should not forget the riparian zone or river banks that are intrinsically linked to the river and its functioning, contributing organic matter to fuel in-stream food webs including terrestrial invertebrates that are consumed by salmonid fishes, and regulating in-stream temperatures. The stretch within the property of Intel Ireland shows what can be achieved when bank-side vegetation and habitats are protected. We need to improve the quality of the riparian corridors along the length of the Rye Water. This will not only enhance the biodiversity of the Rye valley but will also act as a buffer to protect the river from diffuse pollution. Our aim is to facilitate the development of habitat heterogeneity, ranging from riparian woods to fringing meadows and wetlands incorporating native species where planting takes place.

Our vision for the Rye Water valley allows its citizens to appreciate the wealth of the wildlife while at the same time ensuring that we do not disturb or destroy those elements we seek to protect. Clearly the SAC habitats on the Intel lands are protected from general access but the local area provides plentiful opportunity for people to enjoy this natural amenity.

The vision for the Rye Water and its valley needs to be shared with its inhabitants, particularly the younger generation which will carry that vision forward to its fruition.

Glossary of Terms

Alevin	Juvenile fish still attached to the yolk sac
Algae	A collective term for several groups of relatively simple photosynthetic plant forms containing chlorophyll.
Aquatic	Of or relating to water, e.g. plants and animals that live or grow in water.
Biodiversity	The variety of living species. Good biodiversity is fundamental to the efficient functioning of ecosystems on which we rely for food, fresh water, health, recreation, and protection from natural disasters.
Birds Directive	
Bryophyte	A simple, low profile, non-flowering plant, most of which lack vascular tissue; common in damp habitats.
Calcareous	Containing or characteristic of calcium carbonate
Carboniferous limestone	
Catchment	A drainage basin with similar topographic features enclosing part or all of a watershed.
Diel Activity	Relating to daily, meaning activity within 24 hour period.
Diffuse Sources	Pollution which has no clear exact point of origin, often arising from general run-off, for example.
Ecosystem	A group of plants, animals, and other organisms which interact with each other and their abiotic environment.
Ecotone	A transitional region between two ecosystems, in which many species from both adjacent systems can be found, together with some specific to the intermediary environment.
Electrofishing	Electrofishing has become a popular technique for sampling freshwater fish populations over the past 50 years. Electrofishing gear consists of 3 main parts, a power unit device (generator or battery), a transformer and electrodes. The power unit generally produces alternating current. The transformer c onverts the original current to direct current of different voltage and produces the shape, length and frequency of the pulse. A pulsed D.C. method was used on the Rye Water. With direct current the fish is attracted to the anode and repelled by the cathode. The possibility of using direct current for fishing is due to the fact that aquatic organisms (both invertebrates and fish) are immobilized (electronarcosis) when the body voltage from nose to tail exceeds a certain value. With direct current, the fish is first attracted to the anode.

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Erosion	This implies the natural wearing down of river banks by the consistent force of flowing river water.
Fen	Marshy type habitat which is influenced by a mineral catchment affecting the water and nutrients.
Fork Length	The length of a fish taken from the tip of the nose to the fork in the tail. In order for an accurate measurement, the tail should be spread out completely and the length read from the most central point at the end of the tail.
Fry	Juvenile trout or salmon less than one year old.
Glide	A stretch of calm, slow, smooth flowing water in a river or stream.
Habitat Directive	
Juvenile Fish	Young fish that have not yet spawned for the first time.
Limnology	The study of freshwaters.
Liverworts	
Macroinvertebrates	A range of small organisms without backbones which can be seen with the naked eye such as insect larvae and crayfish. Many macroinvertebrates are the main source of food for fish. 'Macro' means large.
Moss	A type of bryophyte; a simple, non-flowering plant, most of which lack vascular tissue; common in damp habitats.
Phytoplankton	A photosynthetic microorganism that can consist of a single cell or small groups of cells, and lives and grows freely suspended near the surface in water bodies.
Pleopod	Abdominal swimming limb in malacostracan crustaceans e.g. crayfish and crabs. Pleopods can be modified for carrying eggs in females.
Point Source	Specific, localized points of origin of pollutants.
Pool	Part of river where the water deepens and runs more slowly.
Population	A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.
Producer	An organism which synthesizes its own nutrition from an abiotic source. These include plants and algae, and often form the base of the food chain.
Qualitative	Descriptive information gathered about the quality or character of a river/site, lacks the precision of quantitative data.
Quantitative	Information which is measureable and can be expressed in precise numerical terms.
Q-values	Irish EPA index of water quality based on aquatic macroinvertebrate communities.

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Recruitment	The survival of individuals from one age group to the next, ordinarily from the juvenile stage to the breeding stage.
Redd	The spawning or nesting area of a salmon or trout
Riffle	Is characterized by shallow, fast moving water broken by the presence of rocks and boulders
Riparian	The vegetated area which borders a river, providing an interface between the river and the land. The riparian zone is known to act as a buffer against river quality deterioration, as it plays a role in soil conservation and provides habitats for species thus encouraging increased biodiversity.
Run	A shallow fast flowing water with little broken water surface.
Salmon	Largest member of the salmonid family. Only one species of salmon Salmo salar, the Atlantic salmon occurs in Ireland.
Surber Sampler	A piece of equipment used to quantitatively sample aquatic invertebrates. It consists of a square frame which sits on the substrate, designating the sampling area. There is a collection net attached, the opening of which is directed upstream so as to effectively collect all animal items from the sampling area.
Substrate	The non-living material on which an organism lives or grows.
Taxon	Macroinvertebrates from any classification level.
Terrestrial	Of or belonging to the land.
Trout	A member of the salmonid family. Known as Salmo trutta the brown trout inhabits most rivers and streams in Ireland.
Tufaceous	A habitat which is affected by limestone usually with large calcareous deposits.
Vibert Box	An artificial redd, which facilitates the planting of fish eggs in a river for the purpose of stock enhancement or research.
Water Framework Directive	
Water Quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Zooplankton	Microscopic animals, and the juvenile stages of larger animals, that live suspended in the water column and that feed on phytoplankton and other zooplankton.

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Flora recorded on the Intel site during an audit of the habitats and species over a one year period (Ní Lamhna and Collins, 2004)

TREES

Common Name	Latin Name	Common Name	Latin Name
Sycamore	*Acer pseudoplatanus*	Aspen	*Populus tremula*
Horse chestnut	*Aesculus hippocastanum*	Wild cherry	*Prunus avium*
Alder	*Alnus glutinosa*	Bird cherry	*Prunus padus*
Strawberry tree	*Arbutus unedo*	Blackthorn	*Prunus spinosa*
Silver birch	*Betula pendula*	Sessile oak	*Quercus petraea*
Downy birch	*Betula pubescens*	Pedunculate oak	*Quercus robor*
Hazel	*Corylus avellana*	White willow	*Salix alba*
Hawthorn	*Cratageus monogyna*	Eared willow	*Salix aurita*
Spindle tree	*Euonymus europaeus*	Goat willow	*Salix caprea*
Beech	*Fagus sylvatica*	Sally willow (grey willow)	*Salix cinerea*
Ash	*Fraxinus excelsior*	Bay-leaved willow	*Salix pentandra*
Holly	*Ilex aquifolium*	Elder	*Sambucus niger*
Walnut	*Juglans regia*	Rowan (mountain ash)	*Sorbus aucuparia*
Juniper	*Juniperus communis*	Whitebeam	*Sorbus hibernica*
Larch	*Larix deciduas*	Yew	*Taxus baccata*
Crab apple	*Malus sylvestris*	Lime	*Tilia platyphyllos*
Scots pine	*Pinus sylvestris*	Wych elm	*Ulmus glabra*
Popular	*Populus spp.*	Guelder rose	*Viburnum opulus*

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FLOWERING PLANTS

Common Name	Latin Name	Common Name	Latin Name
Milfoil	*Achillea millifolium*	Honeysuckle	*Lonicera periclymenum*
Bishops weed	*Aegopodium podagraria*	Forget me not	*Myosotis scorpiodes*
Bugle	*Ajuga reptans*	Red bartsia	*Odontites verna*
Lady's mantle	*Alchimilla xanthochlora*	Poppy	*Papaver rhoeas*
Scarlet pimpernel	*Anagalis arvensis*	Spotted persicaria	*Persicaria persicaria*
Cow parsley	*Anthriscus sylvestris*	Winter heliotrope	*Petasites fragrans*
Arum lily	*Arum maculate*	Butterbur	*Petasites hybridus*
Daisy	*Bellis perennis*	Ribwort plantain	*Plantago lanceolata*
Wild rape	*Brassica rapa*	Great plantain	*Plantago major*
Lady's smock	*Cardamine pratense*	Silverweed	*Potentilla anserine*
Black sedge	*Carex nigra*	Cinquefoil	*Potentilla reptans*
Centaury	*Centaurea erythraea*	Primrose	*Primula vulgaris*
Knapweed	*Centaurea nigra*	Mignonette	*Reseda luteola*
Mouse-eared chickweed	*Cerastium fontanum*	Dog rose	*Rosa canina*
Fat hen	*Chenopodium album*	Bramble	*Rubus fructicosus*
Thistle	*Cirsium arvensis*	Small dock	*Rumex conglomerates*
Bindweed	*Convolvulus arvensis*	Sorrel dock	*Rumex acetosa*
Teasel	*Dipsacus fullonum*	Dock	*Rumex obtusifolius*
Rosebay willowherb	*Epilobium angustifolium*	Ragweed	*Senecio jacobea*
Broad-leaved willowherb	*Epilobium montanum*	Praiseach	*Sinapis arvensis*
Spurge	*Euphorbia helioscopia*	Golden rod	*Solidago virgaurea*
Meadow sweet	*Filipendula ulmaria*	Stitchwort	*Stellaria holostea*
Fumitory	*Fumaria officinale*	Snowberry	*Symphoricarpos albus*
Robin run the hedge	*Galium aparine*	Dandelion	*Taraxacum officinale*
Soft cranesbill	*Geranium molle*	Yellow clover	*Trifolium dubium*
Herb robert	*Geranium robertianum*	Red clover	*Trifolium pratense*
Ground ivy	*Glechoma hederacae*	White clover	*Trifolium repens*
Ivy	*Hedera helix*	Coltsfoot	*Tussilago farfara*
Hogweed	*Heracyleum sphondylium*	Nettle	*Urtica dioica*
Dame's violet	*Hesperis matronalis*	Speedwell	*Veronica chamaedrys*
Catsear	*Hypochaeris radicata*	Vetch	*Vicia cracca*
Purple deadnettle	*Lamium pupureum*	Bush vetch	*Vicia sepium*
Hawkbit	*Leontodon taraxacoides*	Violet	*Viola riviniana*

GRASSES

Common Name	Latin Name
Vernal grass	*Anthoxanthum odoratum*
False oat grass	*Arrhenatherum elatius*
Dog's-tail	*Cynosurus cristata*
Cock's foot	*Dactylis glomerata*
Scutch grass	*Elymus repens*
Meadow fescue	*Festuca pratensis*
Red fescue	*Festuca rubra*
Yorkshire fog	*Holcus lanatus*
Rye-grass	*Lolium perenne*
Canary grass	*Phalaris arundinacea*
Timothy grass	*Phleum pratense*
Common reed	*Phragmites communis*
Meadow grass	*Poa pratensis*

LOWER PLANTS

Common Name	Latin Name
Harts tongue fern	*Asplenium scolopendrium*
Horsetail	*Equistum sp.*
Xanthoria	*Lichen*

Vertebrate fauna recorded on the Intel site during an audit of the habitats and species over a one year period (Ní Lamhna and Collins, 2004)

FISH

Common Name	Latin Name
Eel	*Anguilla Anguilla*
Pike	*Esox lucius*
Stone loach	*Neomacheilis barbatulus*
Minnow	*Phoxinus phoxinus*
Roach	*Rutilus rutilus*
Salmon	*Salmo salar*
Trout	*Salmo trutta*

AMPHIBIANS

Common Name	Latin Name
Common Frog	*Rana tempoaria*

MAMMALS

Common Name	Latin Name
Fallow deer	*Dama dama*
Mountain hare	*Lepus timidus*
Badger	*Meles meles*
House mouse	*Mus musculus*
Rabbit	*Oryctolagus cuniculus*
Grey squirrel	*Sciurus caroliensis*
Pygmy shrew	*Sorex minutes*
Red fox	*Vulpes vulpes*

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Common Name	Latin Name	Common Name	Latin Name
Sparrowhawk	*Accipiter nisus*	Moorhen	*Gallinula chloropus*
Long-tailed tit	*Aegithalos caudatus*	Swallow	*Hirundo rustica*
Kingfisher	*Alcedo atthis*	Herring gull	*Larus argentatus*
Mallard	*Anas platyrhychos*	Pied wagtail	*Motacilla alba*
Swift	*Apus apus*	Grey wagtail	*Motacilla cineria*
Grey heron	*Ardea cinerea*	Coal tit	*Parus ater*
Long-eared owl	*Asio otus*	Blue tit	*Parus caeruleus*
Buzzard	*Buteo buteo*	Great tit	*Parus major*
Linnet	*Carduelis cannabina*	Cormorant	*Phalacrocorax carbo*
Goldfinch	*Carduellis carduellis*	Pheasant	*Phasianus colchis*
Greenfinch	*Carduellis chloris*	Chiffchaff	*Phylloscopus collybita*
Stock dove	*Columba oenas*	Willow warbler	*Phylloscopus trochilus*
Woodpigeon	*Columba palumbus*	Magpie	*Pica pica*
Raven	*Corvus corax*	Dunnock	*Prunells modularis*
Hooded crow	*Corvus corone*	Bullfinch	*Pyrrhula pyrrhula*
Rook	*Corvus frugilegus*	Goldcrest	*Regulus regulus*
Jackdaw	*Corvus monedula*	Sand martin	*Riparia riparia*
Mute swan	*Cygnus olor*	Starling	*Sturnus vulgaris*
House martin	*Delichon urbica*	Blackcap	*Sylvia atricapilla*
Reed bunting	*Emberiza schoeniclus*	Wren	*Troglodytes troglodytes*
Robin	*Erithacus rubecula*	Blackbird	*Turdus merula*
Kestrel	*Falco tinnunculus*	Song thrush	*Turdus philomelos*
Chaffinch	*Fringilla coelebs*	Mistle thrush	*Turdus viscivorus*
Snipe	*Gallingo gallingo*		

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