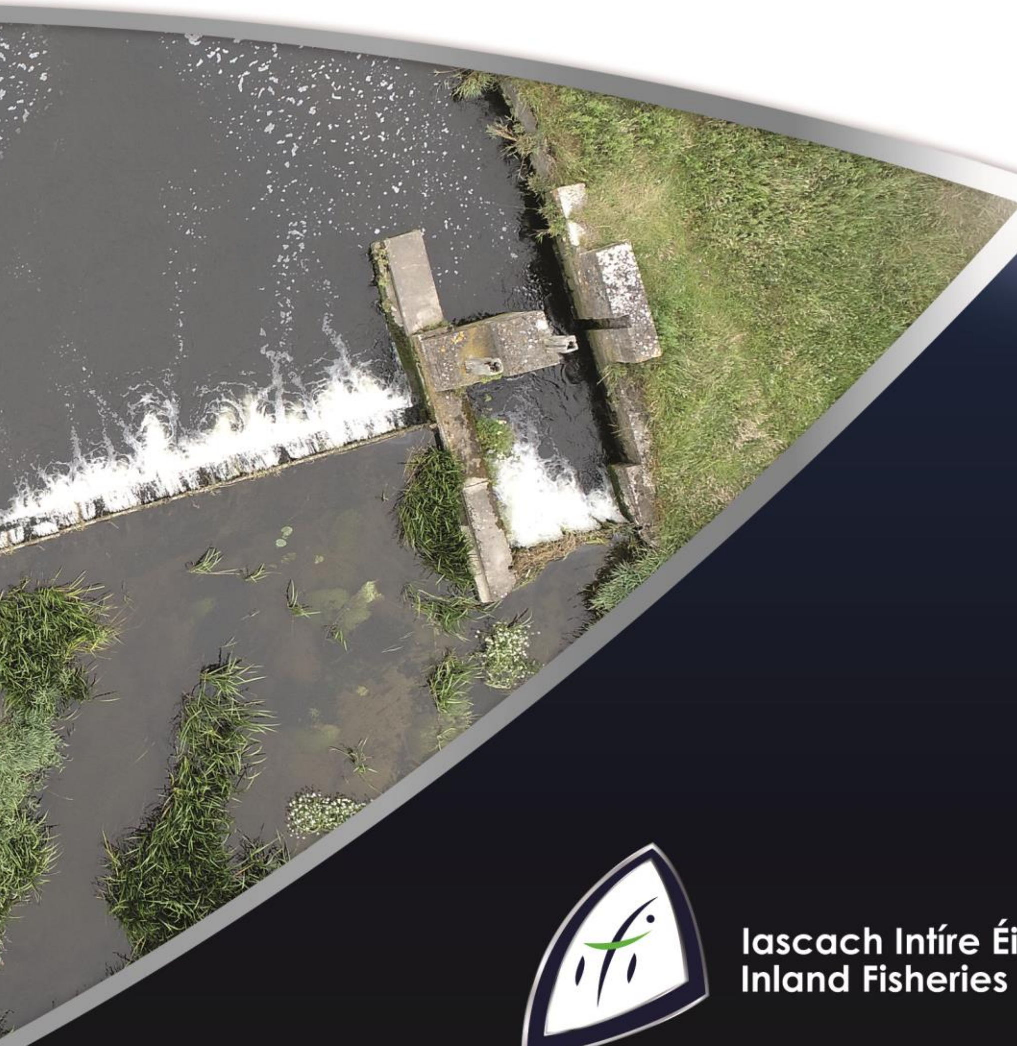
Environmental River Enhancement Programme

Annual Report 2020

IFI/2021/1-4560



Iascach Intíre Éireann
Inland Fisheries Ireland

EREP 2020 Annual Report

Inland Fisheries Ireland & the Office of Public Works

Environmental River Enhancement Programme

Iascach Intíre Éireann
Inland Fisheries Ireland

Oifig na nOibreacha Poiblí
Office of Public Works

Acknowledgments

The assistance and support of OPW staff, of all grades, from each of the three Drainage Maintenance Regions is gratefully appreciated. The support provided by regional IFI officers, in respect of site inspections and follow up visits and assistance with electrofishing surveys is also acknowledged. Overland access was kindly provided by landowners in a range of channels and across a range of OPW drainage schemes.

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Executive Summary

During 2020, a catchment-wide survey was conducted on the Glyde catchment located across counties Cavan, Monaghan and Louth, part of the Glyde & Dee arterial drainage scheme. The majority of sites surveyed were located within the scheme. 25 sites were electro-fished and at 19 of these a hydromorphological assessment was undertaken. Ecological Quality Ratios to assess the status of fish on the Glyde revealed that 64% of sites passed the WFD requirement of Good Status, with the remainder of sites scoring Moderate (32%) and Poor (4%). Using the River Hydromorphology Assessment Technique, 21% of sites passed the WFD minimum requirement of Good status, with 1 site scoring a High status and 3 sites scoring Good. 63% of sites were categorised as Moderate, 16% as Poor and no sites were classified as having a Bad status. 97% of the instream structures identified as potential barriers to fish migration were visited and assessed. Of those surveyed to date, 39 (6.4%) were deemed to be barriers and include 29 bridge aprons/culverts and 7 weirs. 3 of the weirs are on the main stem of the Glyde and as such are more significant passage issues. Agriculture, urban run-off and urban waste water are common significant pressures in the Glyde. Anthropogenic pressures and hydromorphology are other commonly identified pressures. A simple comparison of the results on the Glyde with recent catchment-wide results generated under the EREP reveals that the Glyde compares favourably in terms of fish, RHAT scores and barriers. That said, ongoing pressures mentioned herein put 12 waterbodies at risk within the Glyde, and if allowed deteriorate further, this could compromise the current status or prevent amelioration of fish stocks and hydromorphological quality.

Results from a six-year study on the River Stonyford reveal the change in macrophyte assemblages following a pause in the maintenance programme and installation of fencing for livestock exclusion. Empirical results suggest that faster flow velocities and greater substrate diversity are directly mediated by instream vegetation establishment. Moreover, short maintenance cycles may encourage the proliferation of homogenous vegetation. When left to re-naturalise, interactions between vegetation development, flow velocities and substrate encourage development of diverse habitats that can support a greater range of species. Within its trapezoidal form the river maintains a capacity for self-organisation. Management recommendations are made to encourage these natural fluvial processes and retain valuable instream habitat.

Collaboration between IFI and OPW under the EREP identified opportunities for on-site walkovers and virtual meetings to make progress in a range of areas. These included discussions and walkovers in the field on the application of the Environmental Drainage

Maintenance procedures along with the development of plans for implementing instream enhancement measures. Online meetings resulted in the development of guidance on RHAT surveys and workshops on barrier mitigation.

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1 Introduction

The year 2020 saw the third year in a five year agreement (2018 – 2022) between the Office of Public Works (OPW) and Inland Fisheries Ireland (IFI). The beginning of the year saw personnel changes on the project, and subsequently the arrival of the Covid-19 pandemic worldwide. A series of planned investigations was adapted in line with changing priorities and maintaining safe practices of work for those working in the field on the programme, but also the local communities who live and work in the field survey areas. More time than usual devoted to desk-based research saw the delivery of the longest report on the EREP in recent years, which had a strong hydromorphological emphasis and detailed various outcomes from a suite of long-term studies.

The 2020 field season focussed on the River Glyde for a catchment-wide survey. Survey data on fish and hydromorphology was collected using Water Framework Directive (WFD) compatible methods and metrics. Data on fish populations were statistically modelled and classified using the Fisheries Classification Scheme 2 (FCS2) to generate Ecological Quality Ratios for each survey site. Using the visual observational assessment approach of the River Hydromorphology Assessment Technique (RHAT), scores were generated for a subset of the electro-fishing sites. Using IFI's Barrier Assessment and Screening Tool (i-BAST), developed by the National Barrier Programme, a detailed barrier survey was undertaken in the Glyde catchment, with measurements and photos taken for structures presenting a barrier to fish migration. More detailed surveys were undertaken on the structures on the main River Glyde, to quantify both upstream and downstream passabililty for a range of fish species.

Inter-agency collaboration in person was still ongoing when feasible in 2020, albeit with limited numbers and adhering to standard operating procedures. Walkovers were completed in a number of OPW scheme channels with representatives from IFI (EREP team, Catchment CARE team and regional IFI colleagues), OPW arterial drainage maintenance staff and the Local Authority Waters Programme. Online meetings and workshops with OPW Environment Section facilitated progress on a number of areas including addressing issues arising from the catchment-wide RHAT survey results and barrier mitigation planning.

2 Glyde Catchment-wide Survey Programme

The Glyde catchment is located to in the East of the country, North-West of Drogheda (Figure 2.1) The Glyde rises in counties Cavan and Monaghan. The upper reaches of the river around Kingscourt form the Lagan River [C1(1)]. The other main tributary fed from the headwaters around Carrickmacross is known as the Longfield/Kilanny River [C25(1)]. After their confluence, the main stem of the Glyde [C1(1)] flows in an easterly direction through Tallanstown and Castlebellingham, is then joined by the river Dee just kilometres before discharging into the Irish Sea in Annagassan, Co. Louth (Figure 2.2). The river is 56km in length and drains a catchment area of 340km^2. The western section of the catchment is comprised of areas with higher elevation (327m), whereas the east of the catchment consists of low-lying land. The areas of flat land are heavily cultivated for tillage and pasture. The Glyde was arterially drained as part of the Glyde & Dee scheme with the OPW undertaking works between 1950-57. The majority of channels within the catchment have undergone arterial drainage (Figure 2.3).

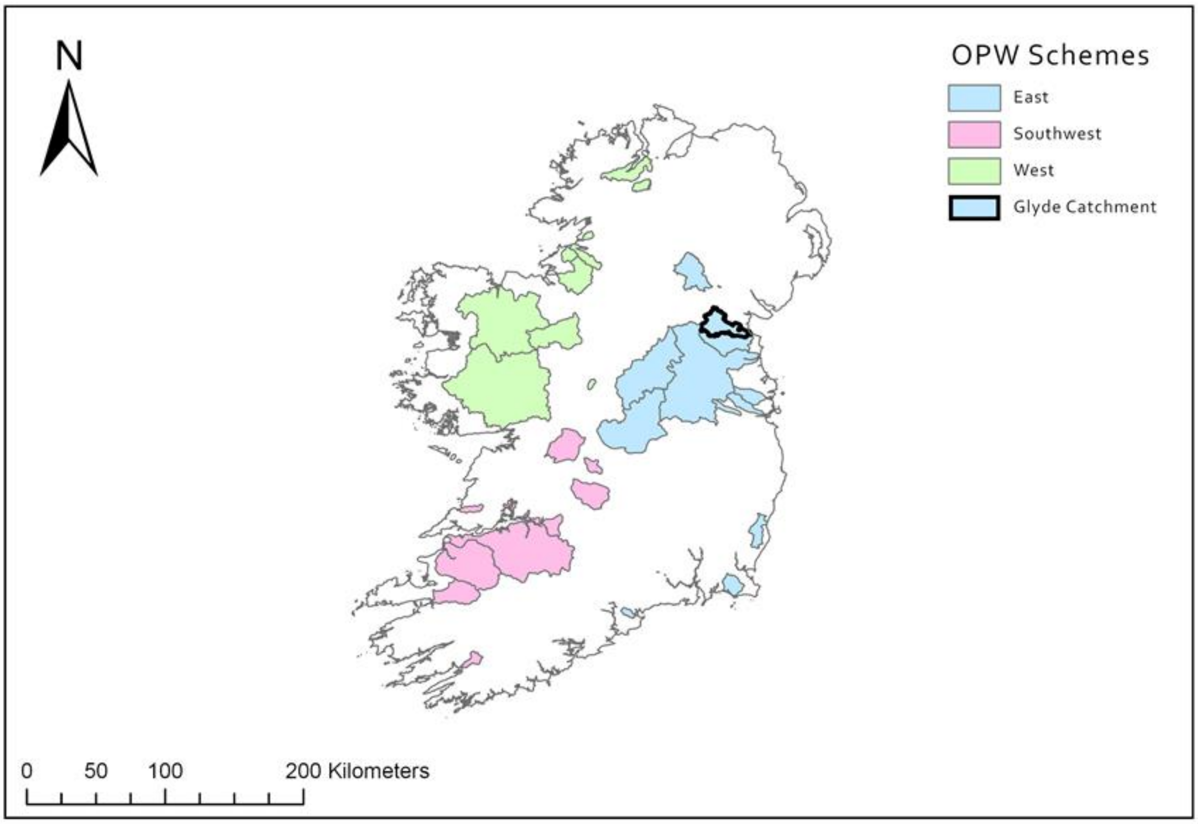


Figure 2.1 Map showing location of the Glyde catchment within OPW Drainage Scheme.

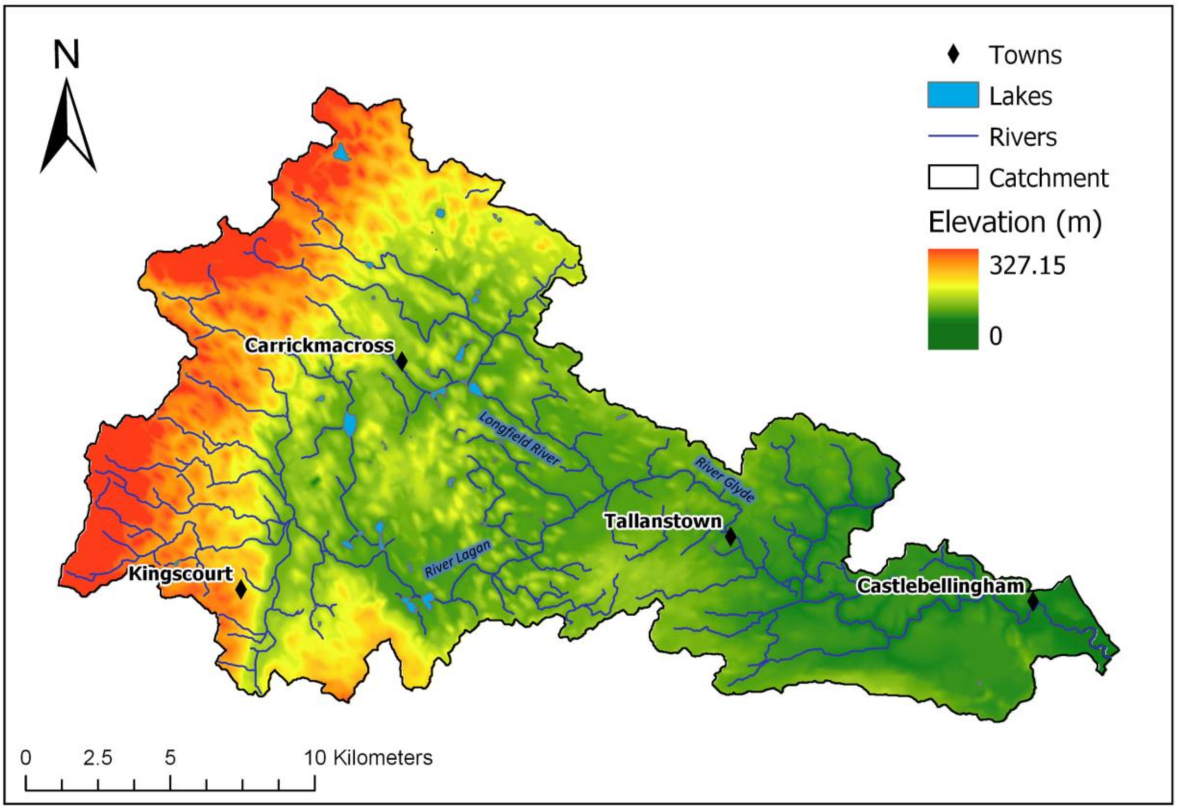
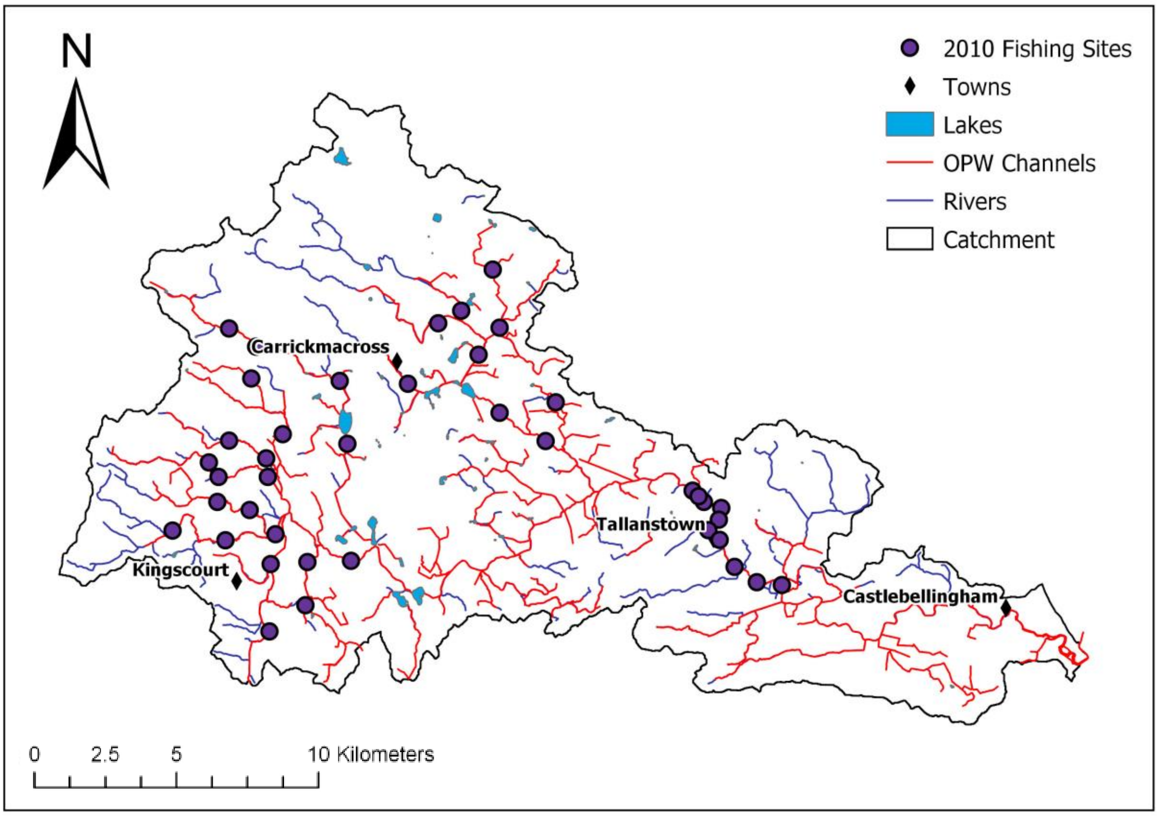


Figure 2.2 Geography of the Glyde catchment showing major tributaries, towns and elevation.

2.1 Fish Population Index

In 2010, 40 sites located across the Glyde Catchment were electrofished by the EREP team, (Figure 2.3) indicating a good distribution of salmonids catchment wide (IFI, 2011). Trout were present at 80% of sites surveyed, along with being the dominant species at majority of these sites. Lamprey were present in 4 upland sites, with suggestion that they may be more widespread in the catchment. Crayfish were not found but may have been present at low levels.

The Glyde catchment was surveyed during the months of August - September 2020. A total of 25 sites were sampled in order to determine density, distribution and population structure of the fish communities (Figure 2.3) along with assessing hydromorphological pressures which could be affecting them.



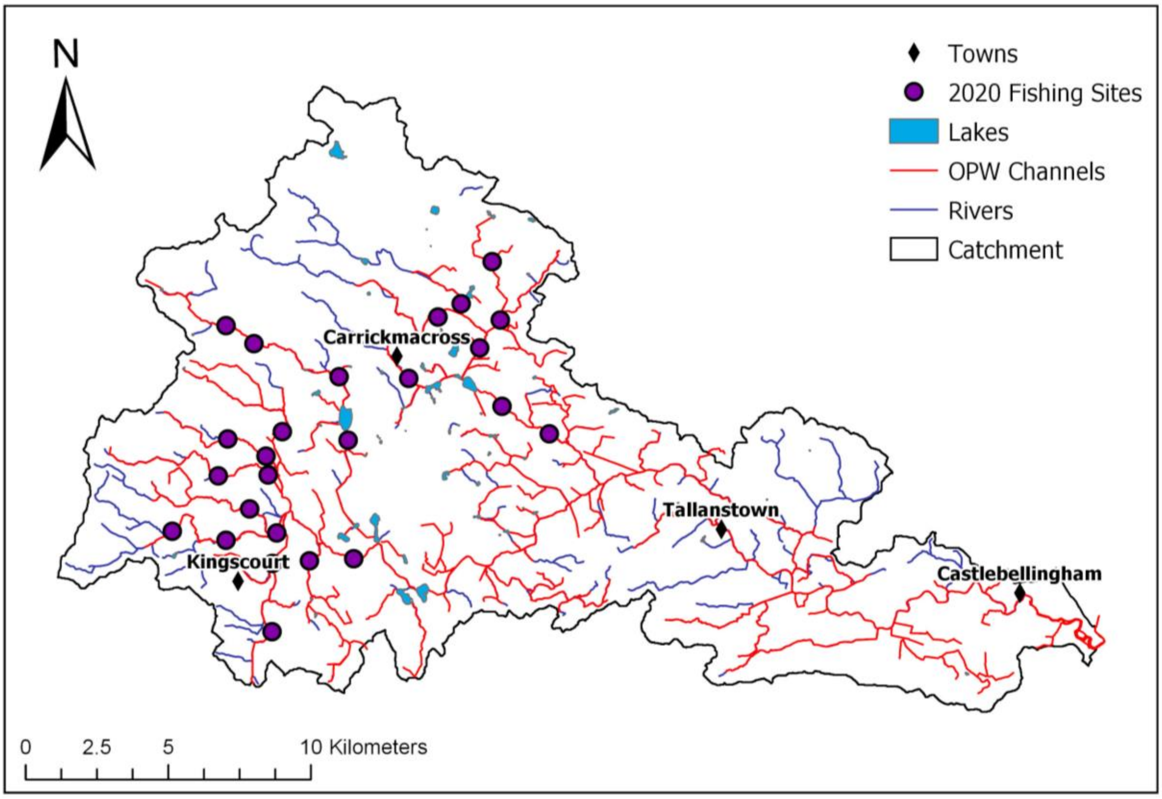


Figure 2.3 Map of the Glyde catchment and locations of electrofishing sites during the FPI Survey 2010 (n = 40) and 2020 (n = 25).

In completing the 2020 FPI survey, 25 bank-based electrofishing sites were fished. No boat fishing was undertaken on the main stem of the Glyde, due to Covid-19 restrictions. The average bank site fished was 27m long and 4.1m wide. In total, 769 fish were captured, measured and returned during the catchment wide survey. Stickleback (n=268) was the most abundant species (Figure 2.4), followed by Brown Trout (n=261) & Minnow (n=93).

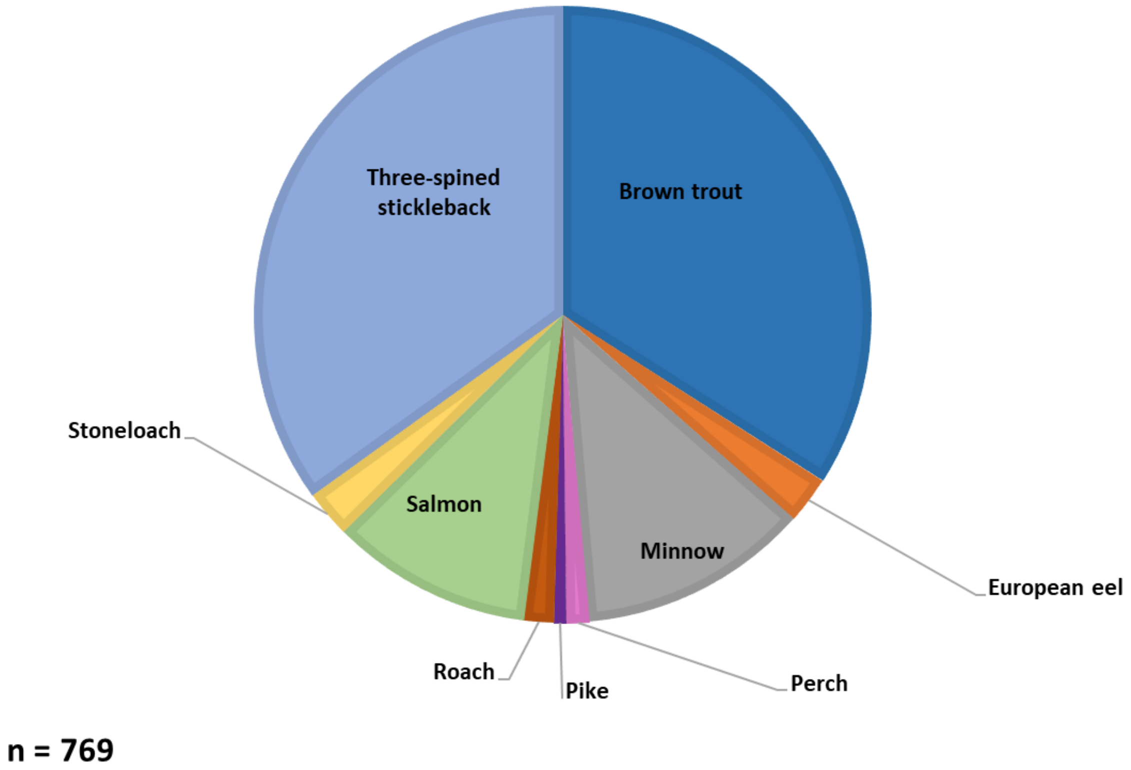
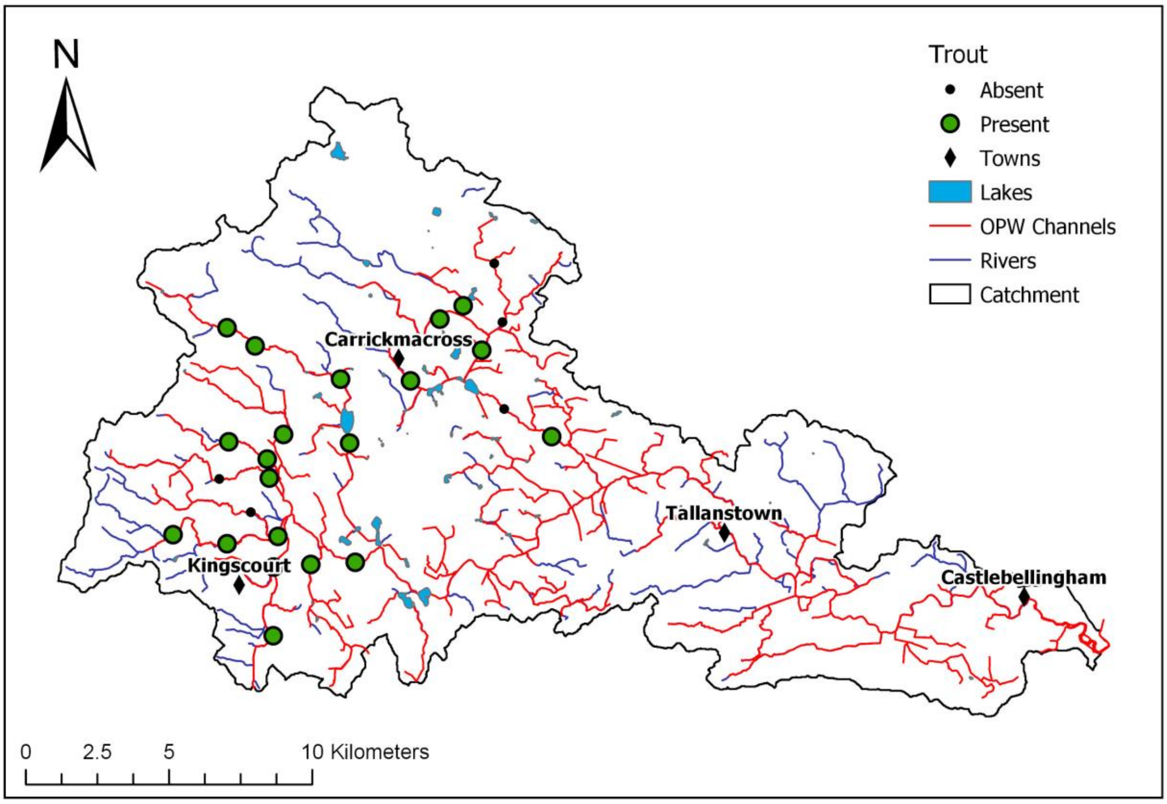


Figure 2.4 Composition of fish species captured during bank-based electrofishing.

Trout were present at 80% of the sites surveyed and Salmon were present at 44% of the sites surveyed (Figure 2.5). There was coarse fish captured in 4 sites (Lurgans, Proules and two sites on Rossdreenagh Stream). The lengths of pike captured at these sites, measured and returned ranged from 15-20cm.

Crayfish where not found is this survey however, it is not possible to discount a dispersed, low level presence in this catchment. No lamprey were recorded although suitable habitat was observed throughout the catchment and may be utilised by lamprey. The 10-minute bank-based electrofishing method is not the optimal approach for capturing lamprey, but rather it is a method used when targeting a multi-species population, as is the case with this survey. The electro-fishing method is optimised by teams within IFI when surveying specifically for lamprey.



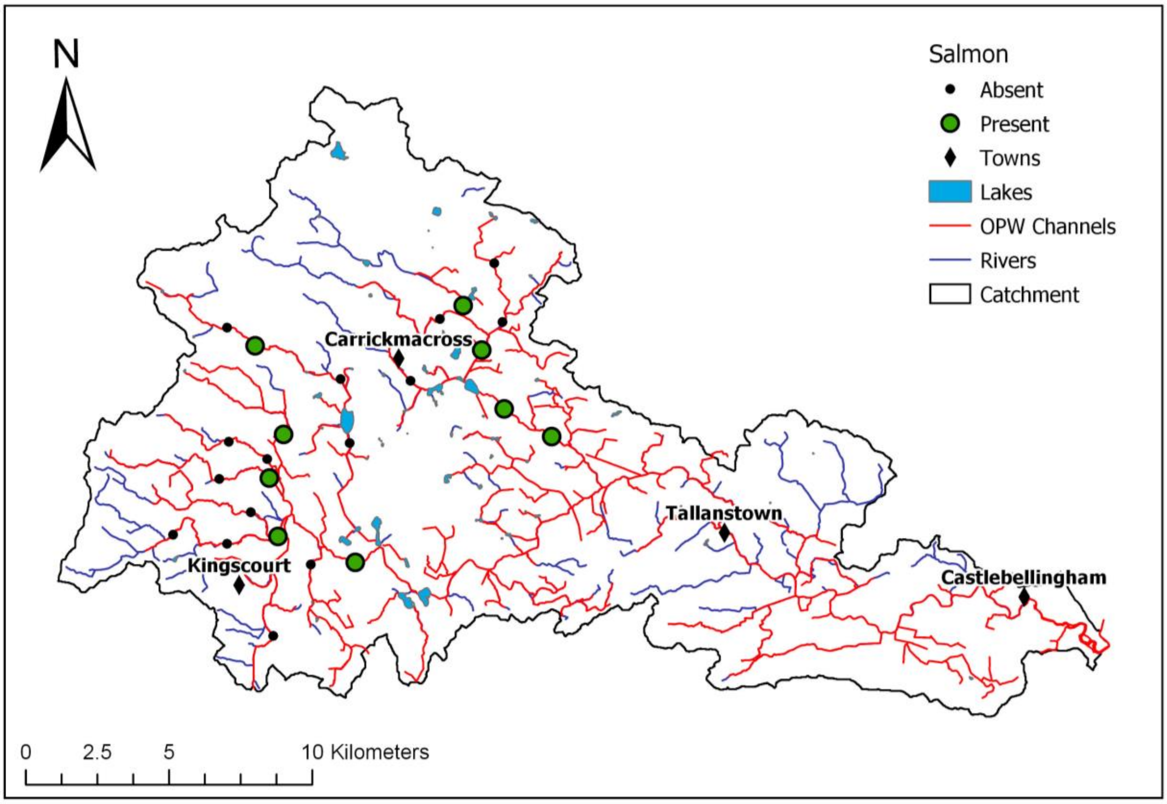


Figure 2.5 Presence/absence of Brown Trout and Salmon at fishing sites in the Glyde catchment.

During the bank-based electrofishing brown trout from a variety of age classes were captured in both years (2010 and 2020). There are three modal peaks evident in the trout length frequency data compiled in Figure 2.6. Both survey years show a similar trend.

Focusing on the 2020 data, fish recorded under 12cm in length were classified as 0+ Trout and there was a prominent cluster of fish in the 7-10cm range. The second modal group, 13-19cm range, was dominated by 1+ fish. Fish measured at 20cm and greater were classed as 2+ year old trout. Bank-based fishing sites focus on stretches of channel where depth is less than 0.5m. These sections generally act as brown trout recruitment and nursery areas.

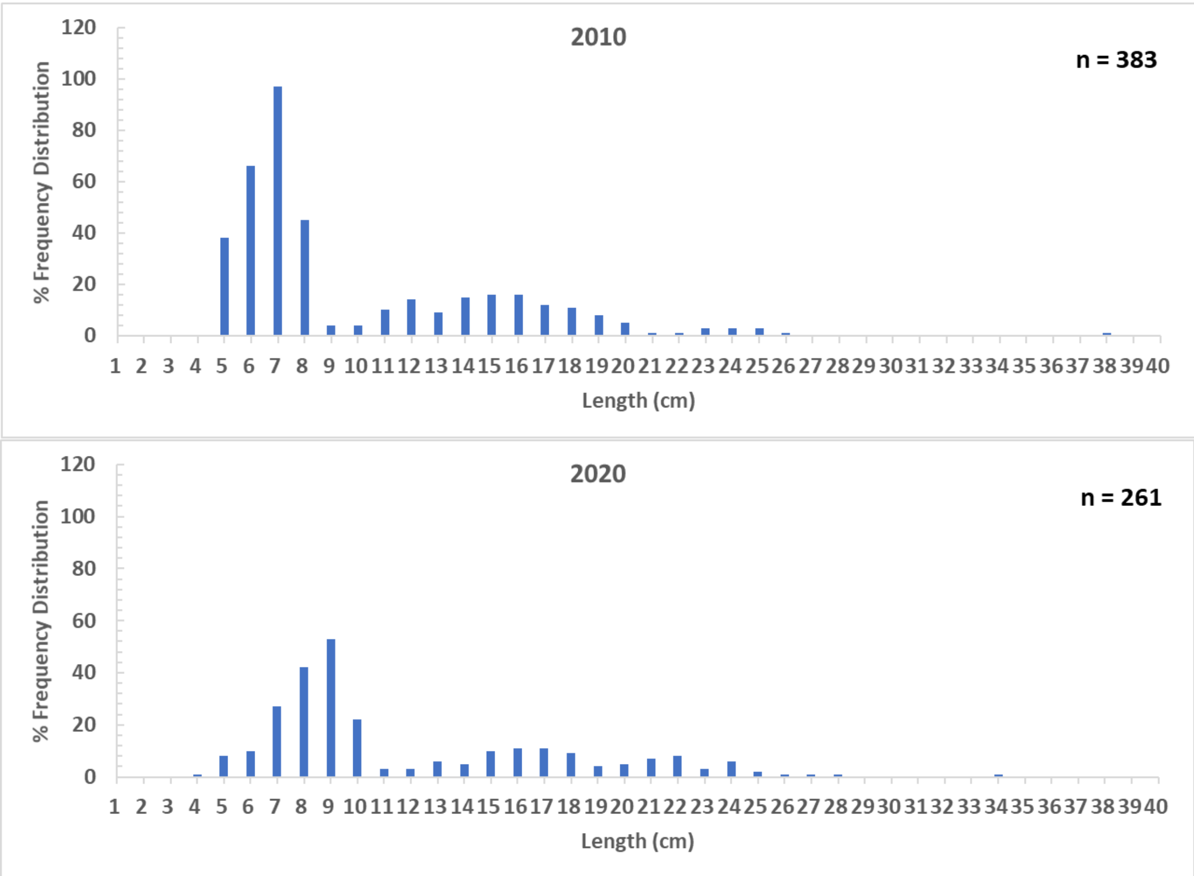


Figure 2.6 Percentage length frequency distribution of Brown Trout captured by bank-based electrofishing from the Glyde FPI Survey in 2010 and 2020.

During the bank-based electrofishing Salmon was captured in both years (2010 and 2020). There are two peaks evident in the length frequency data compiled in Figure 2.7. Similar age classes (0+ and 1+) were captured in both years but in fewer numbers overall in 2020.

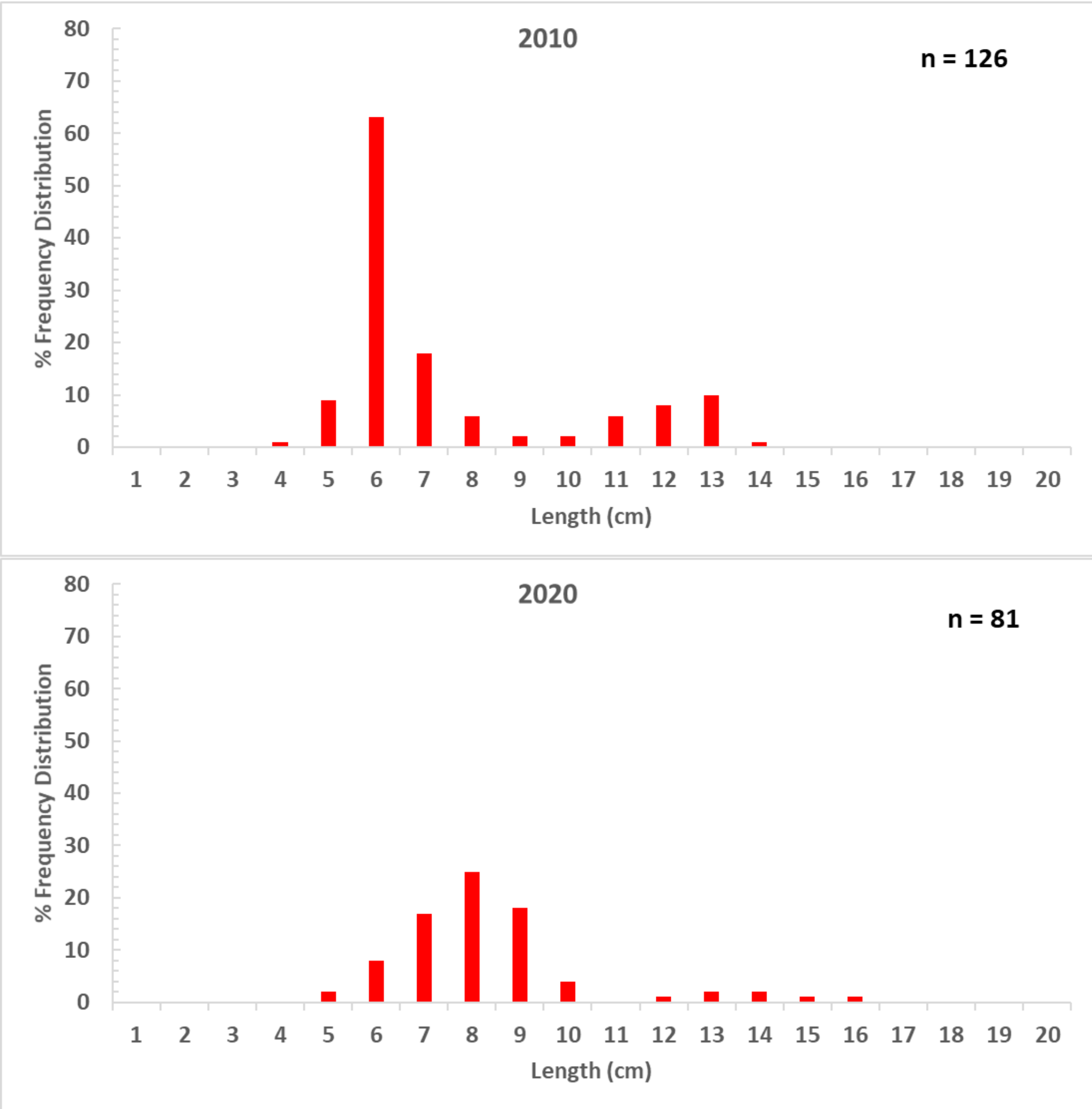


Figure 2.7 Percentage length frequency distribution of Salmon captured by bank-based electrofishing from the Glyde FPI Survey in 2010 and 2020.

The Glyde catchment has been below its salmon conservation limit for the last three years, with the preceding years forecasting a slight surplus (IFI, 2021). There is good scope in some of the upper tributaries for enhancement to promote spawning and nursery habitat. Evidence of capital enhancement on the Cormey, a tributary of the Lagan (Figure 2.8) emplaced by an IFI Eastern RBD project approximately 15 years ago supports good flow diversity and substrate heterogeneity. This mixture of hard and soft engineering approaches, using both stone and wood to create deflectors, is a relatively low-cost solution and has positive effects on the channel form and flows in this reach.

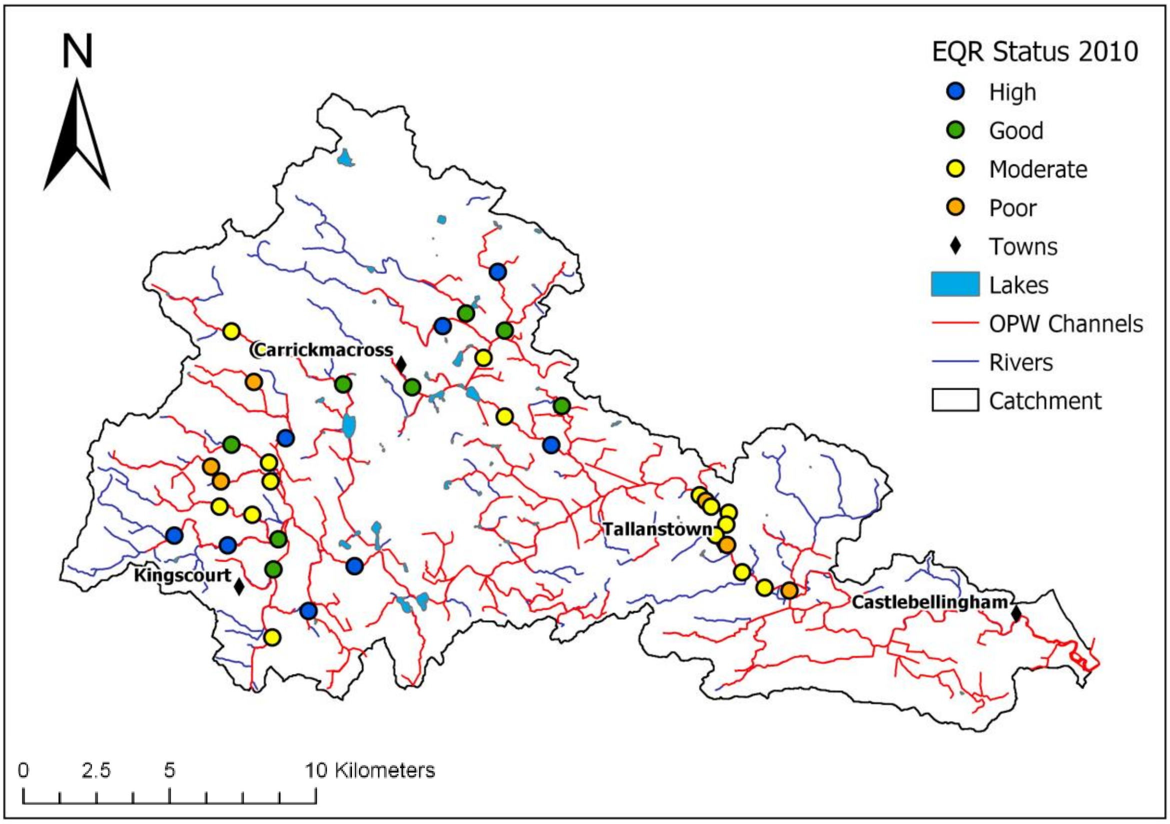
Figure 2.8 Deflectors on the Cormey River.

2.1.1 Ecological Quality Ratio (EQR)

Fish EQR scores were modelled for each site (n=25) electro-fished in 2020 as well as those previously fished by the EREP team in 2010 (n=40) (Figure 2.9). Due to Covid-19 restrictions in 2020, the boat sites on the main channel in particular could not be sampled. Between the two survey years 25 sites were comparable. 32% (n=8) of sites remained the same status for both years, 32% (n=8) of sites were upgraded and 36% (n=9) downgraded. In 2020, 64% of sites passed the WFD requirement of Good Status (or High), with the remainder of sites scoring Moderate (32%) and Poor (4%). This compares with 2010, where 60% of the 25 comparable sites scored Good Status (or High), with remaining sites scoring Moderate (32%) and Poor (8%).

Presence and absence of salmonids influence the EQR scores given to a water body. When calculating an EQR Score for any waterbody salmonids are scored by presence and abundance of both age classes (0+ and 1+ fish). This plays a significant role in the model output. If both 0+ and 1+ salmon/trout are recorded during the fishing survey the waterbody will achieve a higher EQR score, whereas if only one age class was present the riverine system would achieve a lower EQR score. Presence of both classes of salmonids at a given site is an indication of recruitment within the riverine system.

Looking at 2020 data and focusing solely on Trout records, all sites classified as High Status (n=4) had both age classes of Trout present. Those sites graded as having good status (n=12), 59% had both classes present, 33% of sites had 1 age class present, and 8% had no Trout records. The only site classified with a Poor score had no Trout present. Salmon influences EQR scores in a similar way as Brown Trout presence. The EQR scoring system also accounts for the diversity of species present in a waterbody - including lamprey, crayfish, stoneloach, stickleback, minnow and others along with 0+ and 1+ salmonids.



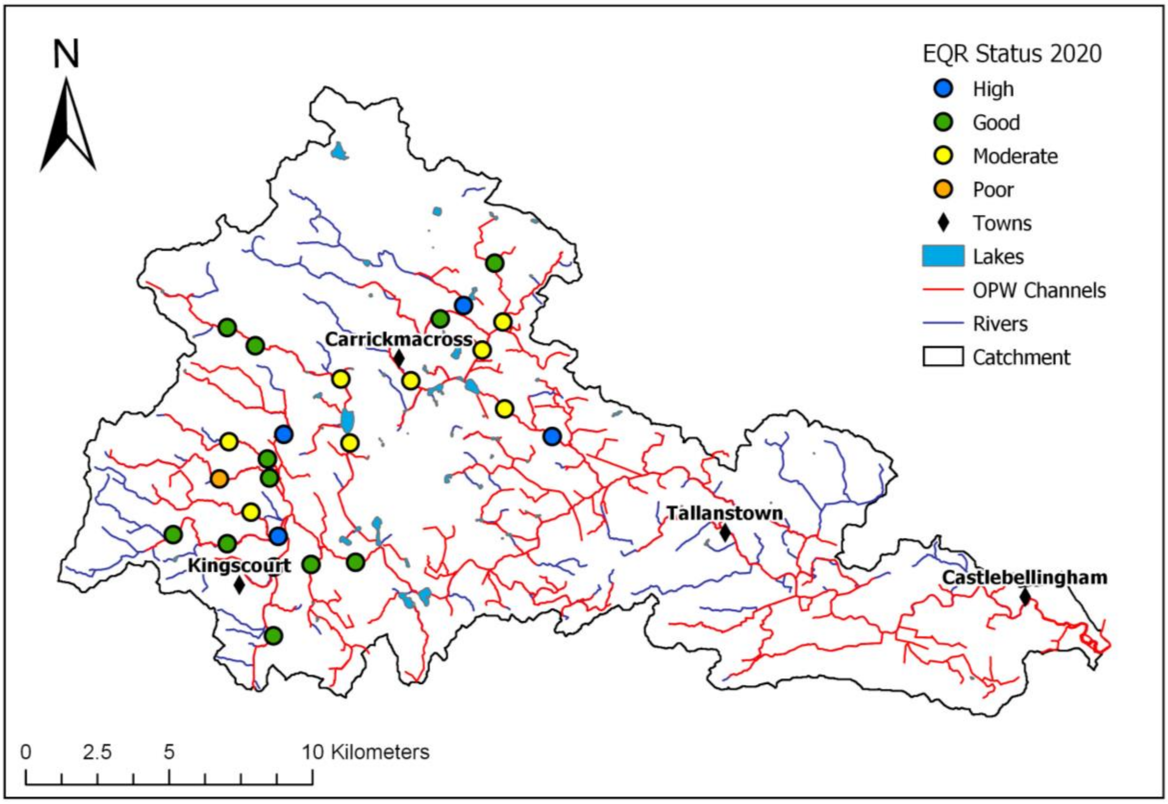


Figure 2.9 Fishing locations with EQR scores for 2010 (n=40) and 2020 (n=25).

2.2 River Hydromorphological Assessment Technique

The main reporting elements of the WFD are the biological quality elements: fish; macrophytes and macroinvertebrates/phytoplankton with physico-chemical parameters and hydromorphological elements supporting the ecological status elements. The River Hydromorphological Assessment Technique (RHAT), a tool developed specifically for WFD, is the Irish reporting method for field assessment of hydromorphological quality (Murphy & Toland, 2014). Hydromorphology describes the interactions of geomorphology and hydrology of a river system in space and time or more simply put, hydromorphology is the physical habitat of a river constituted by the physical form (abiotic and biotic) and flow of the river. Key elements include the flow, groundwater connectivity, continuity and connectivity (longitudinal, lateral, vertical and temporal), channel morphology, substratum, sediment regime, riparian zone structure and the interaction of all these components in both space and in time (Figure 2.10). Man-made features such as bank protection works, artificial barriers (weirs, dams) and modifications to natural riverine processes are also included in assessment of hydromorphology status. The RHAT covers the continuity and morphological condition components but does not assess the hydrological regime (Kampa & Bussettini, 2018).

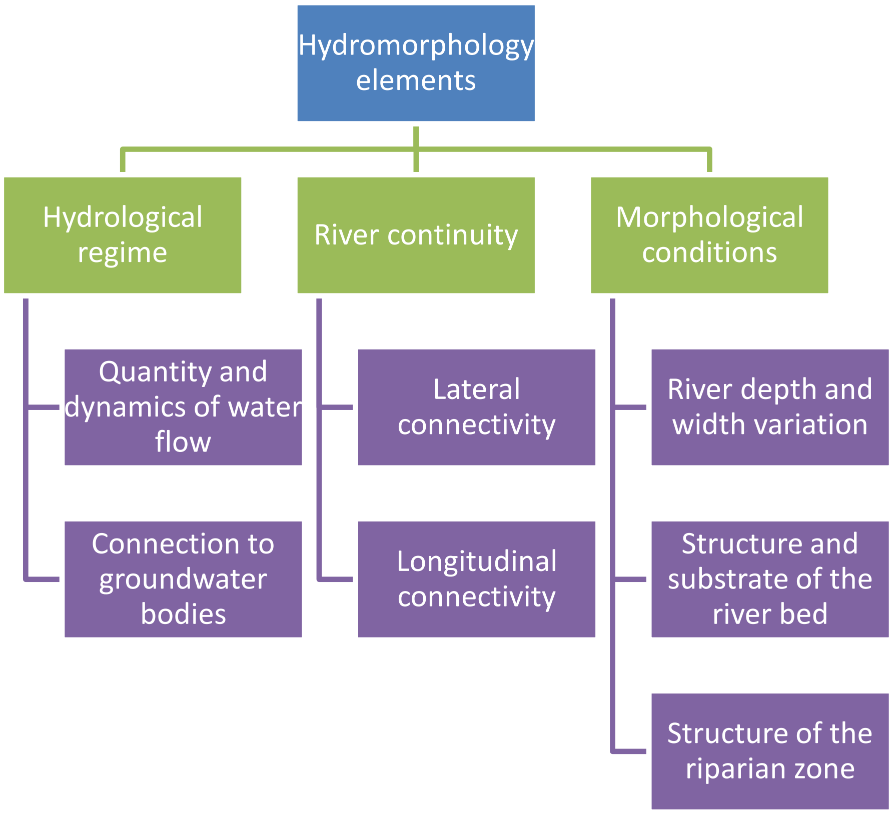


Figure 2.10 Hydromorphological elements supporting the biological elements of the WFD (Directive 2000/60/EC).

A total of 19 sites located across the Glyde catchment, focusing mainly on OPW-drained channels, were surveyed for hydromorphology using the RHAT survey in 2020 (Figure 2.11). Following the methodology, each site represents a 500m survey stretch with observations recorded every 50m. For the site, an overall summary score and associated WFD class is subsequently assigned. From this catchment-wide survey four sites (21%) passed the WFD minimum requirement of Good status - 3 sites scoring Good and 1 site scoring a High Status. 63% (n=12) of sites were categorised as Moderate, 16% as Poor (n=3) and no sites classified as having a Bad status. 18 of the 19 sites were in drained channels with one of the Good sites just upstream of the drainage scheme. The site which scored High status is located on the upper stretches of the Lagan River and flows through a forest (Figure 2.13). It is part of the OPW drainage scheme but is not subjected to routine arterial drainage maintenance due to its surroundings.

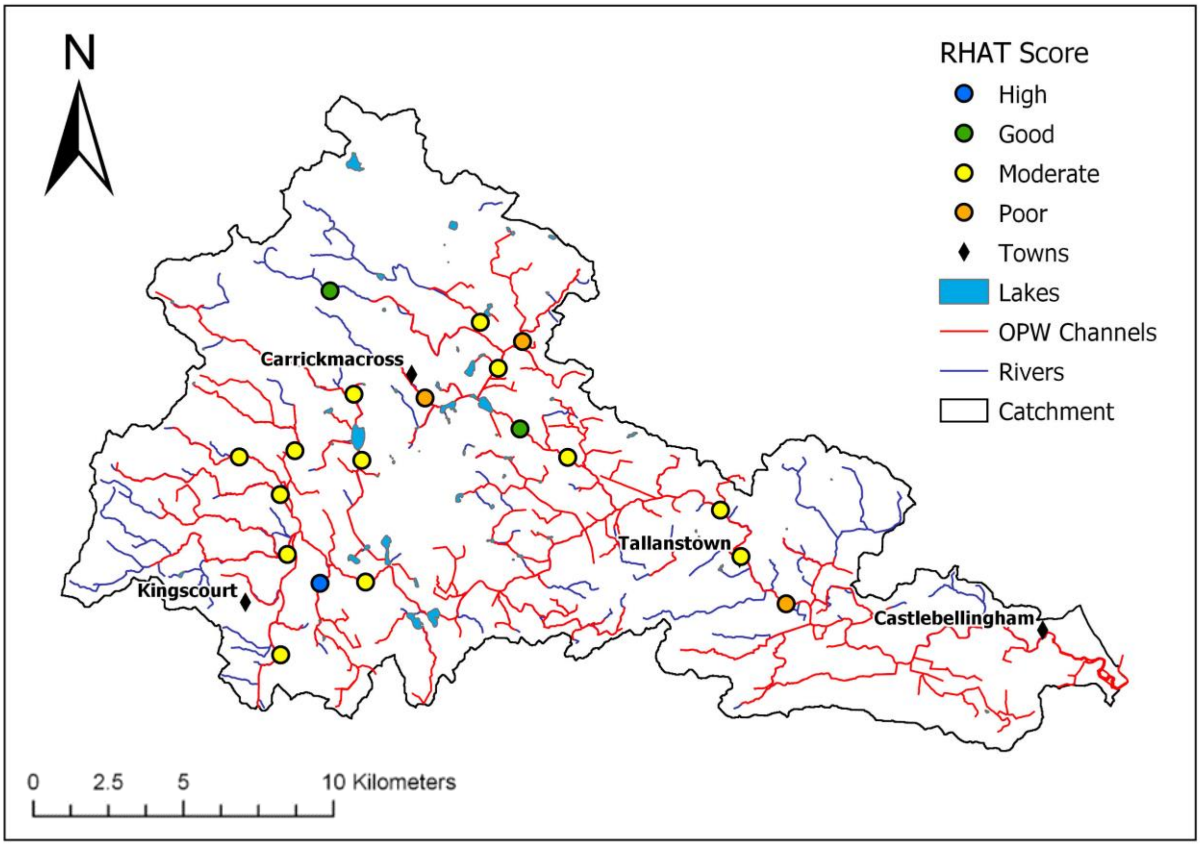


Figure 2.11 RHAT scores for sites surveyed in the Glyde in 2020 (n=19).

The RHAT score is the sum of eight attributes, each of which is scored independently when on site. Each attribute is scored from 0 – 4, with 4 being the highest possible score given per element and all eight are weighted equally. The average score per RHAT attribute from the overall population varies from 1.28 – 2.3 (Figure 2.12). This distribution is expected as the majority of sites (63%) had a Moderate status. Lower average scores include Flood Plain Connectivity, Riparian Land Cover followed by Substrate Condition, with the other five attributes showing averages above 2.

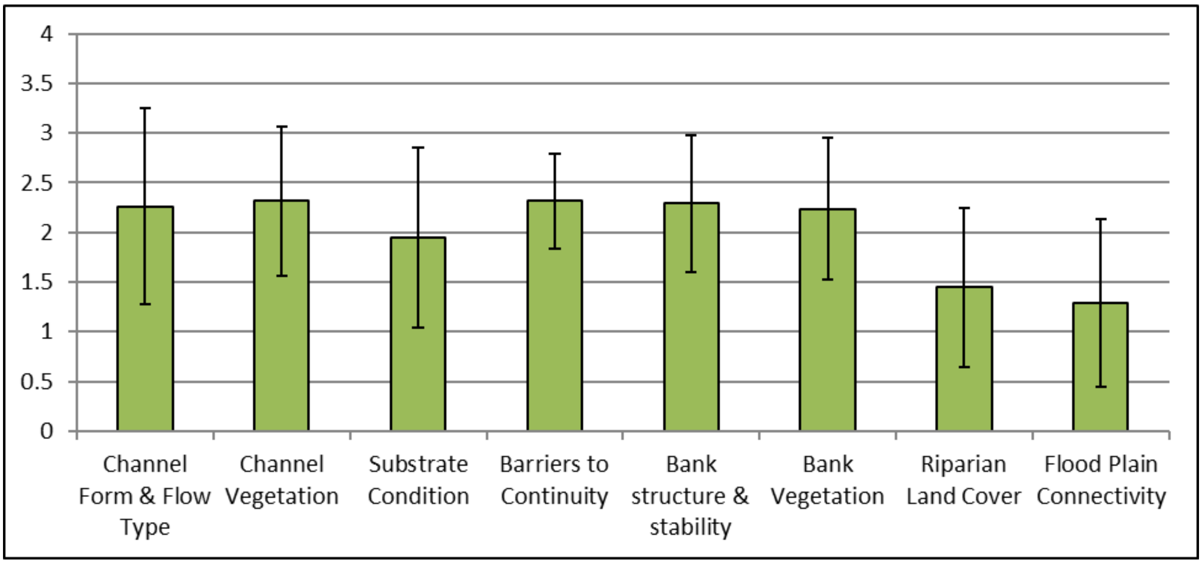


Figure 2.12 Mean and standard deviation for all 8 components of the RHAT survey in the Glyde (n=19).

In arterially-drained catchments, it can be expected that Flood Plain Connectivity would have a low outcome, as the channel becomes isolated from the floodplain by design. Lower scores for Riparian Land Cover can be attributed to land uses such as coniferous plantation, suburban/urban or improved grassland. Substrate Condition can vary according to location within a catchment and river channel pressures, but lower scores are generally due to excessive siltation, where it is not expected. Drainage and maintenance works may be a contributing factor for channels to be in an unsatisfactory hydromorphological condition. Equally, there may be scope to improve hydromorphological condition by implementing measures in the 10-step environmental maintenance guidance (Brew & Gilligan, 2019).

Figure 2.13 Photo of high scoring site on the Cormey River.

This photo (Figure 2.13) is from the only high scoring site [C42(1)] in the Glyde Catchment. Both banks are in their natural state. There is evidence of undercutting and eroding which is an expected natural process for this river type. Tree growth extends to the bank top of both banks provide stabilisation. These banks have not been modified or re-sectioned. It is best to leave this section untouched (Step 5.)

Substrate condition plays a vital role in many stages of a fish's life cycle (Taylor *et al.,* 2019). Clean silt-free gravels are necessary for spawning of salmonids and other aquatic species including sea lamprey. In Figure 2.14, image (a) shows ideal gravels for spawning whereas image (b) shows silted gravels. For gravels to be attractive to adult salmonids for spawning, they need to be clean. To improve substrate condition in [Figure 2.14(b)] Step 9 can be practised (loosen gravel beds). Alternatively, other steps can be practised to ensure the river is self-cleansing including Step 4 (selective vegetation removal), Step 8 (replace stones and boulders) and Step 10 (re-profile channel bed). These steps will change the flow regime of the section of channel in question which will contribute to flushing silt from potential spawning gravels. Selective vegetation removal and strategically positioning boulders into the channel can alter flow direction increase velocities, which will rinse deposited silty substrate downstream. Deepening the thalweg here, creating a simple two stage channel will encourage faster velocities – again washing fine sediment downstream (Fleming *et al.,* 2020).

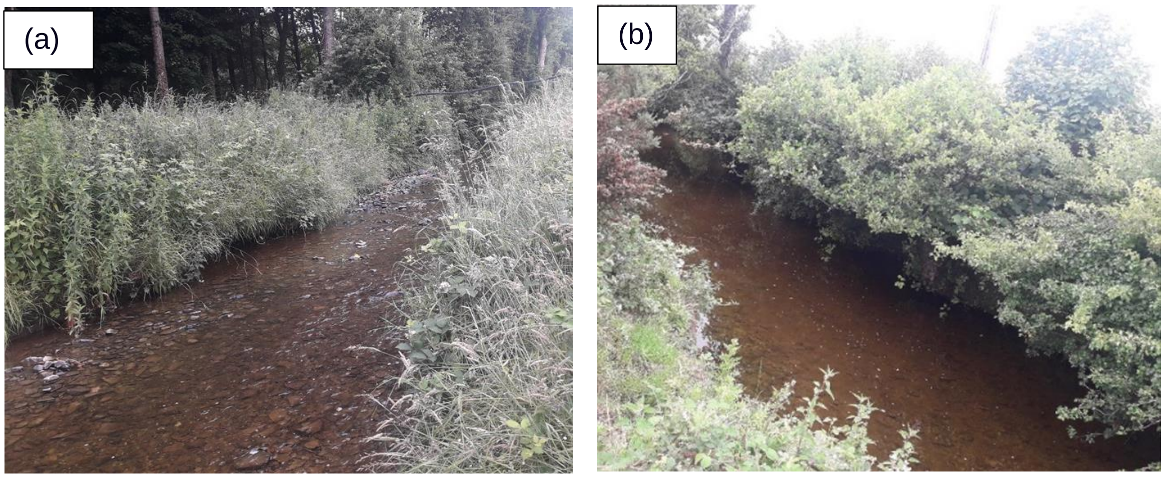


Figure 2.14 Photos showing differences in substrate condition for similar river type – Pool Riffle Glide.

This channel received an overall Poor Score for the entire 500m of the RHAT Survey (Figure 2.15).

Factors influencing this score are:

- No flood plain interaction.
- Lack of canopy cover.
- No buffer zones, with human activities extending too close to the bank tops.

Vegetation is typical for a channel with little gradient and no canopy cover.

Run-off of nutrients from agricultural practices supports instream vegetation growth. Leaving this section untouched (Step 5) is advised – as this vegetation provides much need instream canopy. Buffer zone & tree planting required on both banks tops.

Figure 2.15 Photo taking during a RHAT Survey completed on the Main Glyde in 2020.

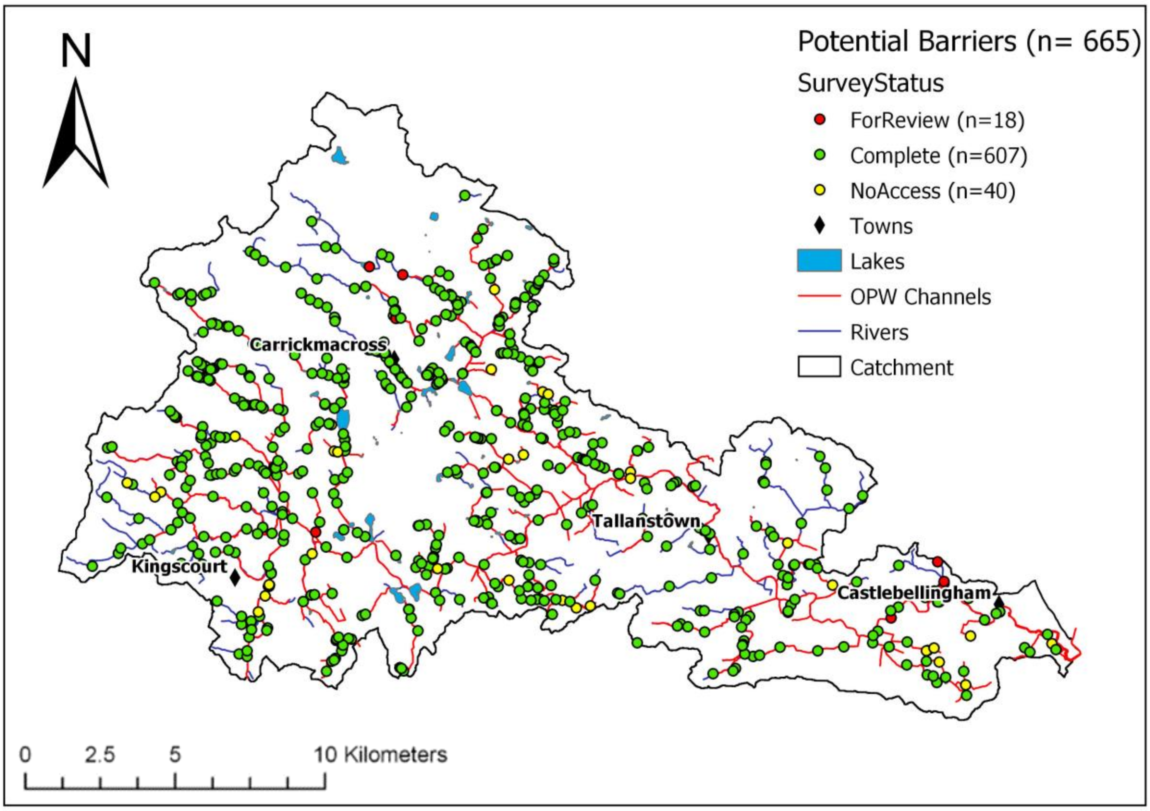
2.3 Barrier Screening and Assessment

Considering hydromorphological elements of the WFD, longitudinal connectivity is a key element of river continuity. The National Barrier Programme being led by IFI has a remit in this area to address the issue of artificial structures within our river channels that impede connectivity within the river corridor. These may include bridge aprons, culverts or weirs. From a fisheries perspective, artificial barriers can disrupt the movement of migratory and resident fish species. Moreover, there can be implications for habitat quality and spawning grounds, and the presence of barriers can alter the likelihood of predation at given locations. From a hydromorphology perspective, artificial structures can impede the sediment supply and transport capacity of the river, affecting fundamental fluvial processes and forms. Moreover there can be implications for water temperature, flood risk, as well as health and safety at artificial structures and ongoing maintenance concerns.

IFI teams began the initial barrier survey of select waterbodies within the Glyde catchment in 2014. Using the Barrier Assessment and Screening tool (i-BAST) developed by the National Barrier Programme within IFI, the EREP team continued this work and surveyed the remainder of the Glyde catchment in 2020 (Figure 2.16). The barrier survey recognises both artificial and natural structures which may affect fish passage. To date, 97% of potential barriers (n = 665) within the catchment have been visited and assessed, comprising 647 survey points in total, with just 18 structures remaining to be reviewed. Access proved difficult in 40 cases, leaving 607 points assessed by the team. Of those surveyed, 6.4% (n=39) represent a barrier to fish migration and measurements for these were taken in the field (Table 2.1, Figure 2.16).

Table 2.1 Barriers identified and assessed in the Glyde catchment survey 2020

Structure type	Number
Culvert / bridge apron	29
Weir	7
Other	2
Natural – rock/bedrock	1
Total	**39**



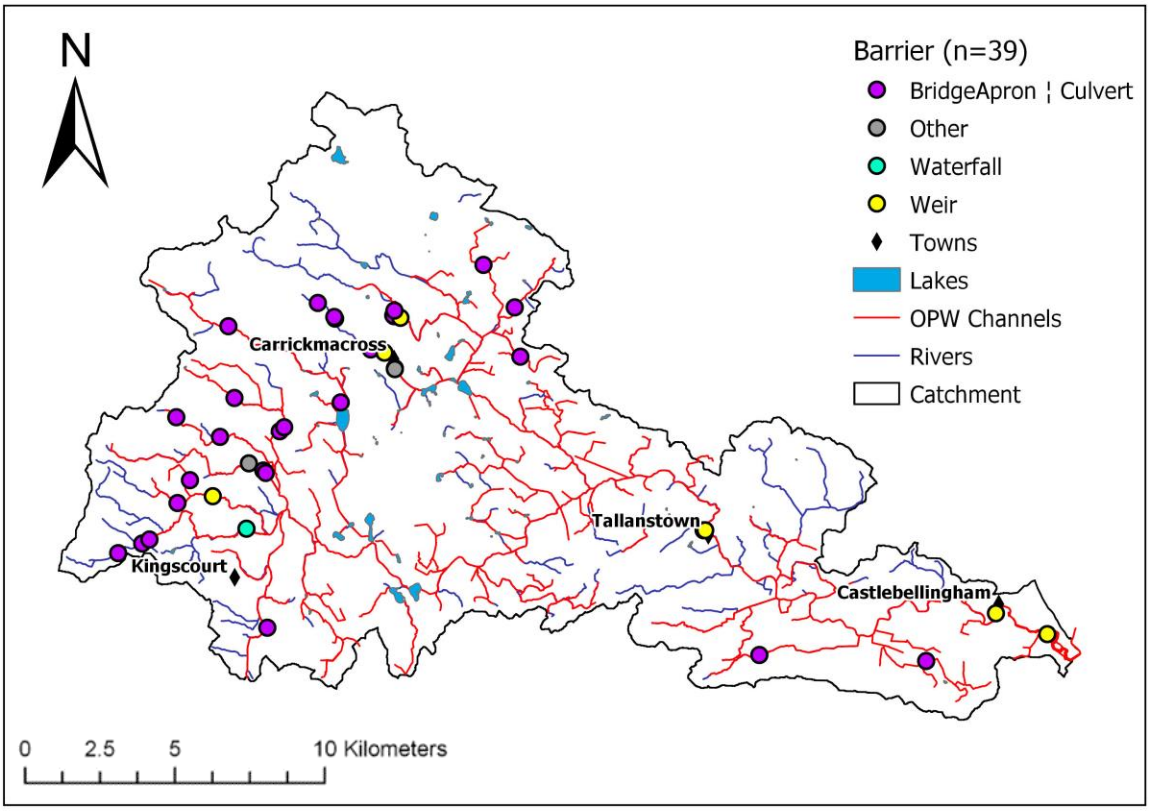


Figure 2.16 Distribution of all potential barriers within the Glyde catchment with survey status to date (n=665). Barriers assessed and surveyed (n=39).

431 of the 665 potential barrier points in the Glyde catchment are on the OPW structures database, and at least 15 of those are categorised as barriers, comprising 38% of the total number of barriers in the Glyde catchment. Examples of structures in OPW channels presenting a challenge to fish migration are shown in Figure 2.17. Some show small but significant drops representing a 'jump' barrier – the effect of cumulative jumps presents a more significant challenge. Others show shallow water over the base of the culvert which indicate a 'depth' barrier to both resident and migratory fish during the majority of the year when water levels aren't elevated. Ongoing work by OPW and IFI on barrier mitigation options may offer solutions to fix issues such as these in the coming years.

Figure 2.17 Examples of barriers identified during the Glyde survey, including two bridge aprons, a box culvert and double pipe culvert.

2.3.1 SNIFFER Surveys in the Glyde Catchment

There are three structures on the main stem of the Glyde which are more significant threats to fish migration. These are located at the tidal limit upstream of Annagassan, Castlebellingham and Tallanstown (Figure 2.18). The weir in Lynns townland at the tidal limit is just 2.2km from the confluence with the River Dee. It combined with another at the tidal limit on the nearby Dee to supply a mill race harnessing power for industry at Annagassan. These are both visible on the Ordnance Survey 25-inch maps, indicating a late nineteenth/early twentieth century origin (Ordnance Survey Ireland, 2017). The weir at Castlebellingham is 4.8km upstream from the Dee confluence and has a similar origin timewise but was built on the location of earlier industrial infrastructure visible on the preceding OS 6-inch maps. It is likely ornamental, built as part of the Castlebellingham estate. The weir at Tallanstown is 21km upstream of the Dee confluence and has a later origin. It is a crump weir, used as a gauging station as part of the OPW monitoring network. In collaboration with the National Barrier Programme, these three weirs were surveyed using the WFD111 methodology developed by SNIFFER (Scotland and Northern Ireland Forum for Environmental Research, 2010).

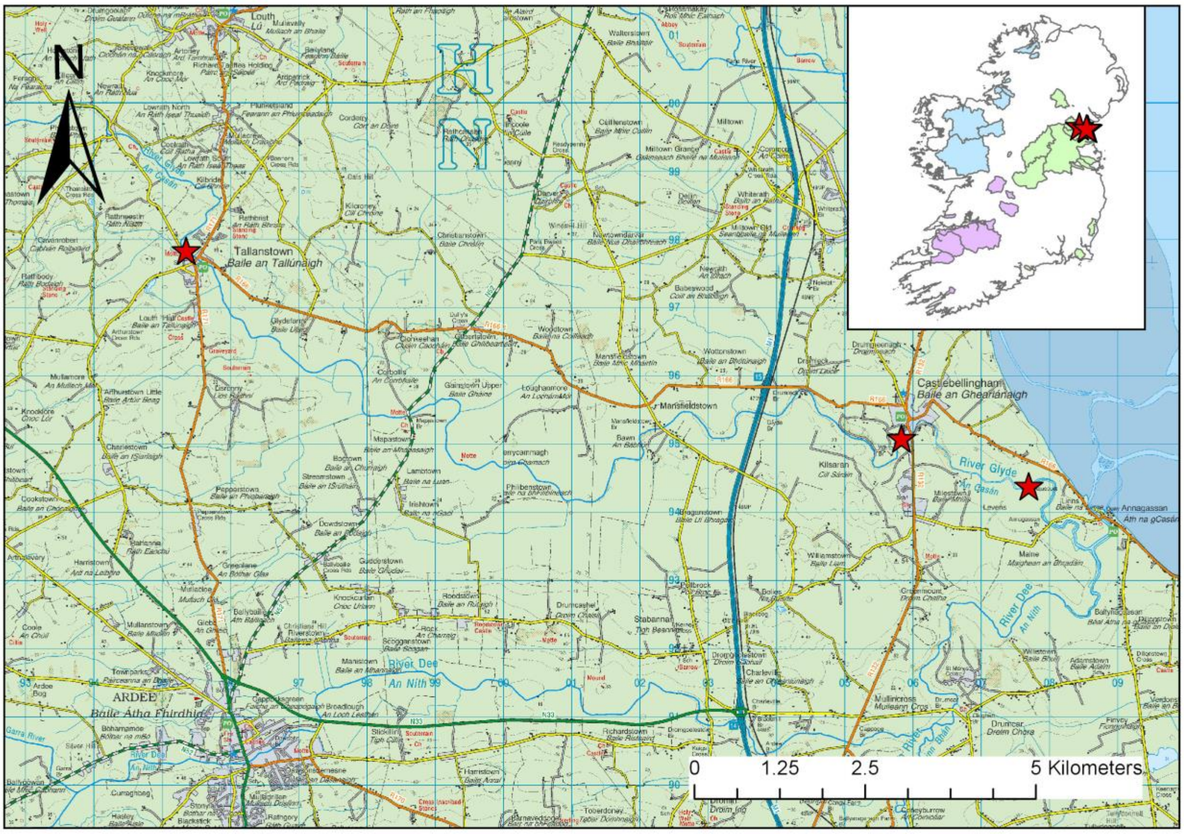


Figure 2.18 Location of weirs where SNIFFER surveys were undertaken on the main stem of the River Glyde.

The following is an overview of the SNIFFER surveys at the three weirs in order, from downstream to upstream. The results of all the surveys are specific to the date of the survey and river conditions at the time. Lynns and Castlebellingham surveys were conducted with during slightly elevated water levels and during Tallanstown survey, the water levels were low.

Two transversals were examined on Lynns weir – the sluice and a fish pass (Figure 2.19). The sluice is not a passage option and was a Complete Barrier on the day of the survey due to the large vertical hydraulic head and limited flows. Same for eels, the fish pass is the only feasible transversal for the remaining species considered in the survey. The height of steps within the fish pass and turbulence make passage upstream through this transversal challenging. On the day of the survey, the fish pass is a Low Impact Partial Barrier for salmonids, a High Impact Partial Barrier for lamprey and juvenile salmonids, and a Complete Barrier to cyprininds.

Figure 2.19 Lynns weir has two transversals: fish pass and sluice.

Castlebellingham weir has two transversals – the vertical weir face and a fish pass at the side of the weir alongside the sluice gate (Figure 2.20). The weir face is a Complete Barrier or High Impact Partial Barrier to most species due to the large hydraulic head and shallow pool depth, so the fish pass is a more feasible option for passage upstream. On the day of the survey, the fish pass is a Low Impact Partial Barrier for salmonids and a Complete Barrier to cyprininds, lamprey and juvenile salmonids. Again the presence of a climbing substrate meant passage for eels upstream was not an issue.

Figure 2.20 Castlebellingham weir has two transversals: fish pass and vertical weir face.

Tallanstown weir has one transversal – the sloping weir face (Figure 2.21). On the day of the survey, it was a High Impact Partial Barrier for salmonids, lamprey and juvenile salmonids, and a Complete Barrier to cyprinids. The angle of the slope, shallow water depth over the surface of the structure, and turbulence beneath the structure make upstream passage problematic. In elevated flow conditions, the relatively small hydraulic head would enable passage for salmonids. The presence of a climbing substrate on the weir face meant passage for eels is not an issue.

The upstream passability assessment for all three weirs on the main stem can be seen in the summary graphic (Figure 2.22) as concluded on the day of the survey. In elevated flow conditions the passability would vary. All three represent partial barriers for adult salmonids and a complete barrier to cyprinids. Adult lamprey and juvenile salmonids face partial high impact barriers or complete barriers.

Figure 2.21 Tallanstown weir with one transversal: sloping weir face.

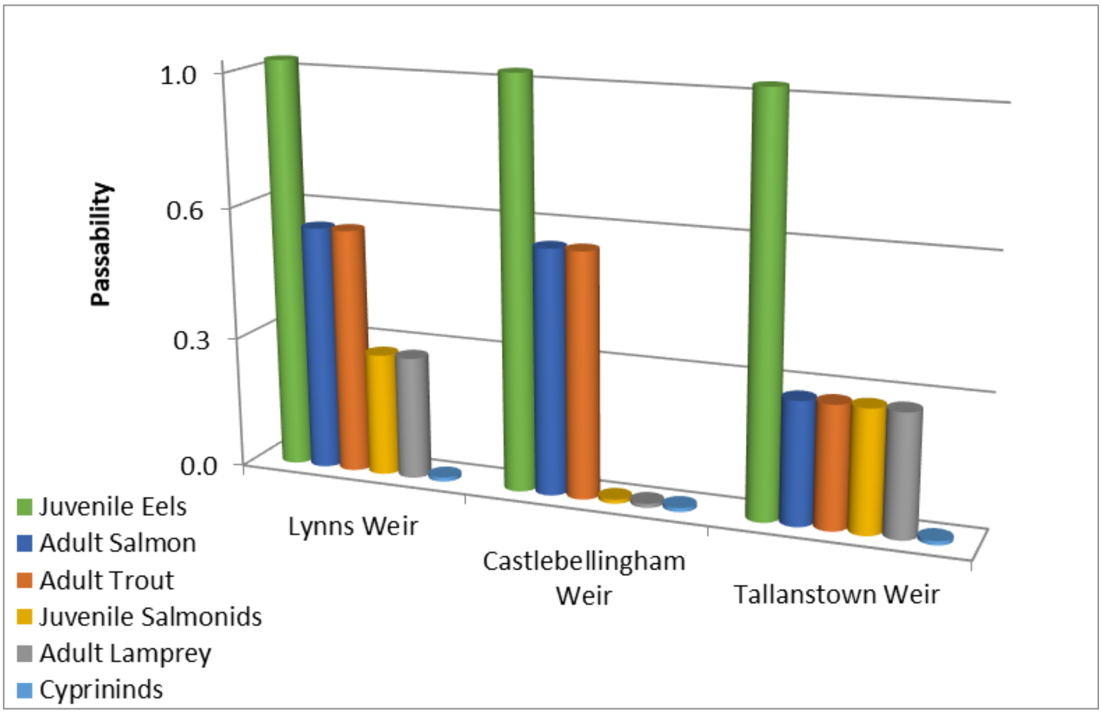


Figure 2.22 Passability assessment for the three weirs on the Glyde. The 0-1 scale is as follows: 0 - Complete Barrier; 0.3 - Partial High Impact Barrier; 0.6 - Partial Low Impact Barrier; 1 - Passable Barrier.

2.4 Catchment context

2.4.1 Water quality

Evaluating data publicly available on EPA website (2021a), results from their long-term monitoring sites indicate that there is a shift in water quality for some waterbodies. Focusing on data recorded at 11 operational sites, 3 sites were upgraded, 4 sites remained the same and 4 sites deteriorated in status. Good Status for a water body is a requirement for the WFD. In 2009, 18% of sites scored High Status whereas 9% scored High in 2019. 63% of sites scored Good Status which passes WFD requirements (Figure 2.23). Salmonids generally fare better at Q3 and above sites i.e. Moderate, Good or High (Kelly *et al.,* 2007). In comparison with salmon, trout would be the more tolerant species and smaller numbers of salmon are generally found in Q3 sites. Non-salmonids dominate the fish populations at poor quality sites (Q2-3). The latest Q-values indicate that there is good water quality in the majority of sites in the catchment, which in turn support the fish populations observed in the catchment-wide survey, especially at some sites in the upper tributaries.

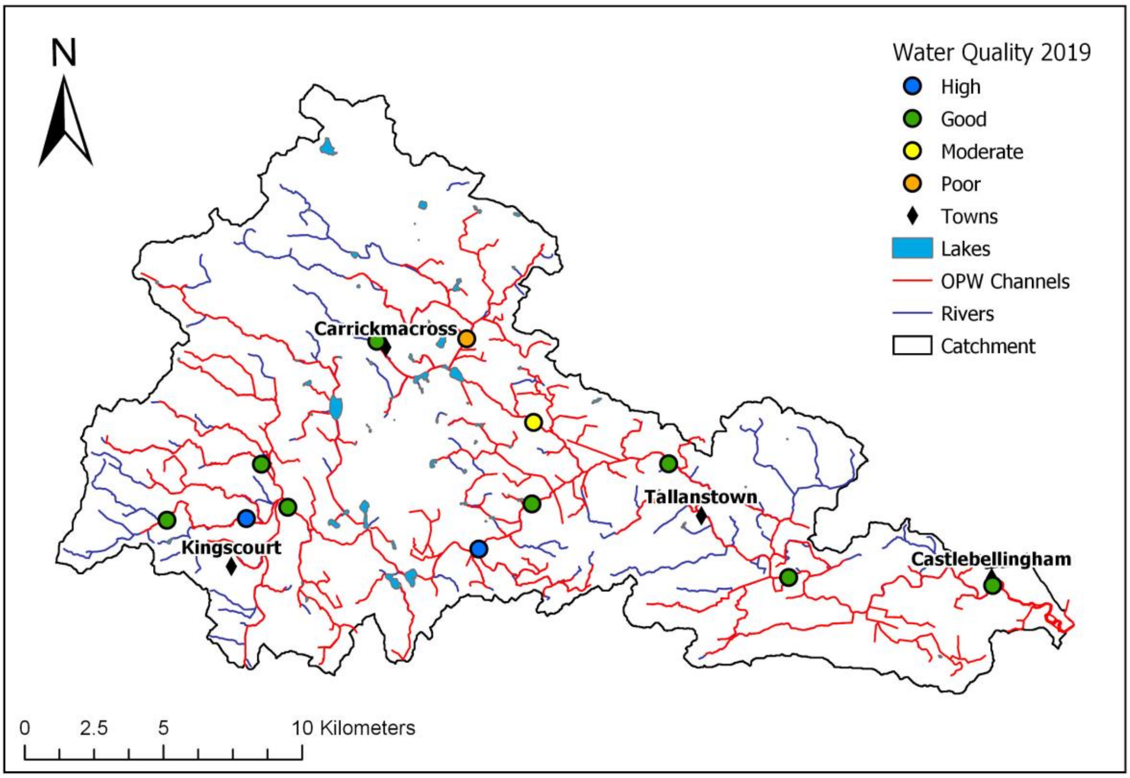


Figure 2.23 Location of operational sites with water quality status recorded in 2019.

2.4.2 Pressures

Data can be retrieved on various governmental websites (EPA, 2021a; 2021b) at a catchment, subcatchment or waterbody level to assess what pressures exist in the region. Within the Glyde catchment, under the EPA GIS categorisation there are 3 subcatchments (Glyde_SC_010; Glyde_SC_020; Glyde_SC_030). From the subcatchment assessment process, pressures and impact have been characterised for individual waterbodies. Using the most up to date information (EPA, 2021b) this information is synthesised in Table 2.2 per subcatchment.

Table 2.2 Land use and pressures per subcatchment within the Glyde

Subcatchment	Urban area(s)	Land use (*main)	Pressures (*significant)	At risk water body (total number)
Glyde_SC_010	Kingscourt	**Pasture*** Mixed forests Gypsum mines Aggregate quarries	**Agriculture*** Anthropogenic pressures **Extractive industry*** Hydromorphology **Urban run-off*** **Urban waste water***	1 river (4) 1 groundwater (4)
Glyde_SC_020	Carrickmacross	**Pasture*** Arable Peat	**Abstractions*** **Agriculture*** Anthropogenic pressure Domestic waste water **Hydromorphology*** **Invasive species*** **Urban run-off*** **Urban waste water*** **Waste (dumping)***	5 rivers (6) 3 lakes (4) 0 groundwater (2)
Glyde_SC_030	Tallanstown, Castlebellingham	**Arable*** Pasture	**Agriculture*** **Anthropogenic pressures*** Hydromorphology **Urban run-off*** **Urban waste water***	2 rivers (6) 0 groundwater (1) 0 coastal (1)

Agriculture, urban run-off and urban waste water are common significant pressures across waterbodies in all 3 subcatchments. Anthropogenic pressures and hydromorphology are other common identified pressures, with the latter being significant in one subcatchment. The specific subcategory within hydromorphology is channelisation and indeed drainage scheme channels exist in all 3 subcatchments. In the subcatchment where it is listed as significant (Glyde_SC_020) there were 7 RHAT surveys completed – in the area around Carrickmacross (Figure 2.11) – with 2 sites scoring Good, 3 scoring Moderate, and 2 scoring Poor. One of those Good scores is just upstream of the drainage scheme channels, and therefore is outside of OPW remit and not subject to maintenance.

On a national scale, agriculture has been highlighted as the dominant land use and also as the most significant pressure on water quality in the recently published EPA report *Ireland's Environment* (EPA, 2020). Nutrient input from agriculture and waste water has significant impacts on water quality. Hydromorphology was listed as the second most significant pressure on water bodies nationally. This pressure encompasses physical alterations to the river channel and banks or flow regime and can be brought about through a variety of measures including channelisation, land drainage, dredging, flood protection works, abstraction and removal of riparian vegetation.

2.5 Conclusion

A simple comparison of the catchment-wide survey results conducted under EREP from 2017-19 in other drained catchments – namely the Inny and Deel – is presented to put the results on the Glyde survey into context (Coghlan *et al.*, 2018; McCollom *et al.*, 2019; Fleming *et al.*, 2020). It should be noted that the characteristics of the catchments are different in that the Glyde and Deel are both smaller (<550km^2) and coastal whereas the Inny is in the midlands with an area of 1383km^2 and is part of the larger Shannon river basin. Moreover, the number of site surveys per catchment varied each year.

Examining the ecological quality ratio scores, 64% of sites in the Glyde passed the WFD requirement of Good status, compared with just 13% for the Deel no sites in the Inny (Table 2.3). Overall the fish population index in the Glyde compares favourably with these two drained catchments.

Table 2.3 EQR and RHATs broken down by proportion per WFD category for the Inny, Deel and Glyde.

	EQR			RHAT		
	Inny (n=77)	Deel (n=47)	Glyde (n=25)	Inny (n=51)	Deel (n=26)	Glyde (n=19)
High			16%			5%
Good		13%	48%	4%	19%	16%
Moderate	28%	53%	32%	39%	50%	63%
Poor	71%	34%	4%	54%	27%	16%
Bad				4%	4%	

In comparison with the other coastal catchment, there are more significant fish passage problems on the Deel with 13.3% of surveyed structures to date categorised as a barrier to fish migration including 6 significant structures on the main stem in comparison to 6.4% assessed as barriers with 3 being significant structures on the main stem of the Glyde. The proportion of barriers with respect to total surveys completed is 10% on the Inny (Table 2.4). Regarding the RHAT survey, 21% of sites on the Glyde have Good status or above with 19% on the Deel and just 4% on the Inny. Of the status below Good, the Glyde has a higher proportion assigned Moderate status in comparison to the Deel or Inny.

Table 2.4 Barrier surveys in the Inny, Deel and Glyde (*some surveys outstanding not included in any of these figures)

	Inny	Deel*	Glyde*
Barrier	155	68	39
No barrier	1399	443	568
Total surveyed	1553	511	607
Barrier %	**10%**	**13.3%**	**6.4%**

3 Stonyford River “Passive Restoration” Fencing Experiment

O’Briain, R., Shepard, S., McCollom, A. and Coghlan, B.

3.1 Introduction

The objective is to quantify the effects of a commonly adopted stream rehabilitation methodology (fencing) on a hydromorphologically altered stream. The rehabilitation strategy is to exclude the pressure of livestock by fencing from the riverbank, providing cattle drinks and allowing the riparian bankside vegetation and instream channel to recover (see locations in Figure 3.1). The key research issues under investigation are:

- The response of riparian and aquatic vegetation to fencing in the medium term (3-5 years), and its effect on physical habitat quality in the longer term (6-10 years)
- The response of channel morphology to vegetation succession
- Effect of vegetation succession on flow regime and bed sediment patterns
- The response of the fish community to vegetation succession (3-5 years) and to associated habitat changes in the longer term (6-10 years)

The basic experimental design is a BACI (before, after, control, impact) style design with the target channel [Stonyford tributary (C1/32/33)] in the Boyne Arterial Drainage Scheme monitored for ten years.

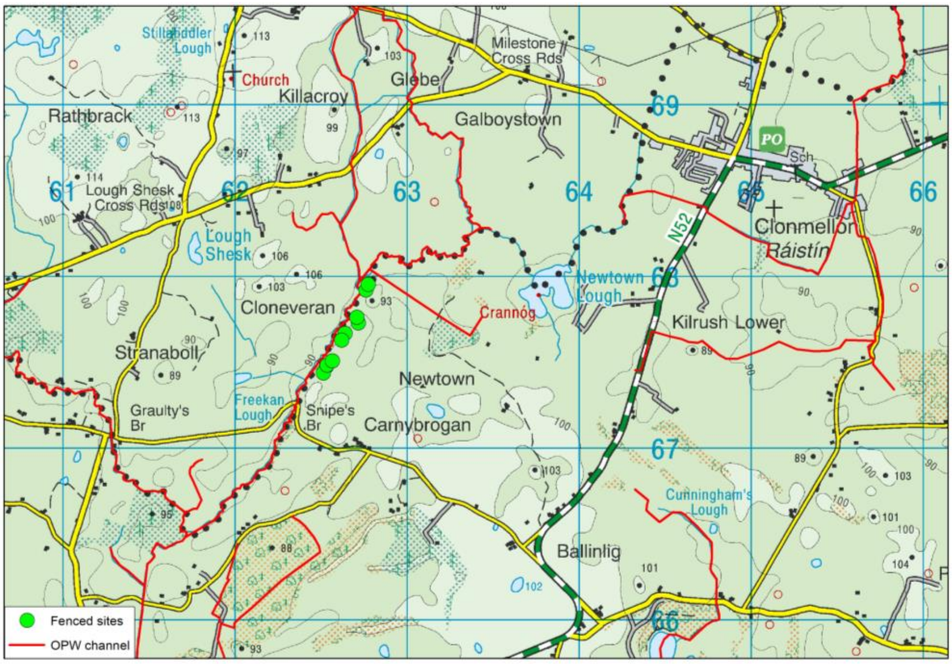


Figure 3.1 Map showing the location of the Stonyford channel (C1/32/33) where fencing and monitoring was undertaken.

This section is reporting on channel response six years post fencing and six years since the last channel maintenance. The short-term response (post two years) study has been published in the peer-reviewed journal *Ecological Engineering* (O'Briain *et al.,* 2017). Findings on same were also presented in the EREP annual reports 2016, 2017 and 2018 documenting the initial short- and medium-term responses, with a particular emphasis on changes in the fish community (IFI, 2017; Coghlan *et al.*, 2018; McCollom *et al.,* 2019).

3.2 Methodology

Five sample sites were distributed within a 1 km non-shaded section of the Stonyford river, a tributary of the River Boyne. It is a characteristic lowland river with low-moderate flow velocities (maximum recorded velocity at sample sites = 0.75 m s^{-1}), abundant macrophytes and a mixed bed load. The river has been arterially drained and channel morphology exhibits many characteristics typical of channelisation e.g., deeply incised, trapezoidal form that isolates the river from its historical floodplain, and uniform flow dominated by extended glides. The channel has also been subject to cyclical river maintenance which has helped to maintain a very homogenous physical form.

Data was collected in late July of 2013, 2014, 2016-2018 and 2020. A series of lateral transects were used to estimate plant frequency/distribution and physical attributes (depth, flow and substrate type) in N=5 30m sample sites within the experimental river sections. Plant presence was recorded in 31 cross sections spaced every 1m at each sample site. Physical attributes (depth, flow and substrate type) were recorded in 11 cross sections spaced every 3m. Substrate type was determined in the field by visual inspection and categorised as fines (≤ 3mm), gravel (4-64mm) or cobble (65-190mm) (Fluskey 1989), according to the dominant type (>60%) at each sample point. Where no substrate type was clearly dominant, it was recorded as mixed (fines/gravel, fines/cobble, gravel/cobble). Samples across lateral transects were subsequently also interpreted as longitudinal transects, i.e. N=5 parallel downstream transects in each study reach.

3.3 Results

Two morphotypes (O'Hare *et al.*, 2016), branched broad leaved emergent (BBLE) and linear emergent (LE) were consistently the most dominant macrophytes recorded across reach and sample years (Figure 3.2). Their mean percentage frequency cover across reaches ranged from approximately 30-45% pre dredging and subsequent fencing in 2013-2014. This cover increased to a peak of 78% in 2017, three years post dredging/fencing, before declining to 57% by 2020. Species within the BBLE group consisted predominantly of Water cress (*Nasturtium officinale* L.) and Fools water cress (*Helosciadium nodiflorum L.)* and were widely distributed within the wetted channel. Tall linear emergent (LE) consisted of Reed canary grass (*Phalaris arundinacea* L.) and Burr reed (*Sparganium erectum* L.) and was typically limited to the channel margins.

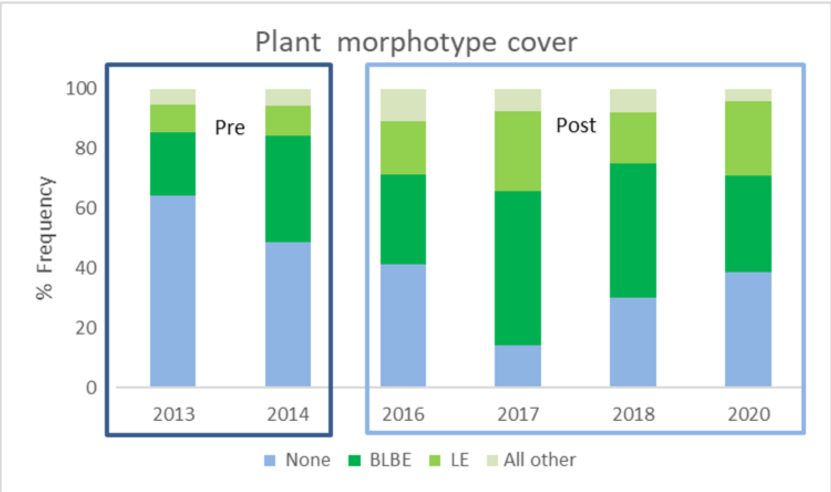


Figure 3.2 Changes in plant morphotype cover pre (navy box) and post (blue box) fencing and channel maintenance.

Fine sediment substrate accounted for 50-70% prior to channel maintenance in the winter of 2014, followed shortly after by fencing (Figure 3.3). Fine material declined to approximately 35% in 2016, but increased in subsequent years, until it dropped back to approximately 30% in 2020.

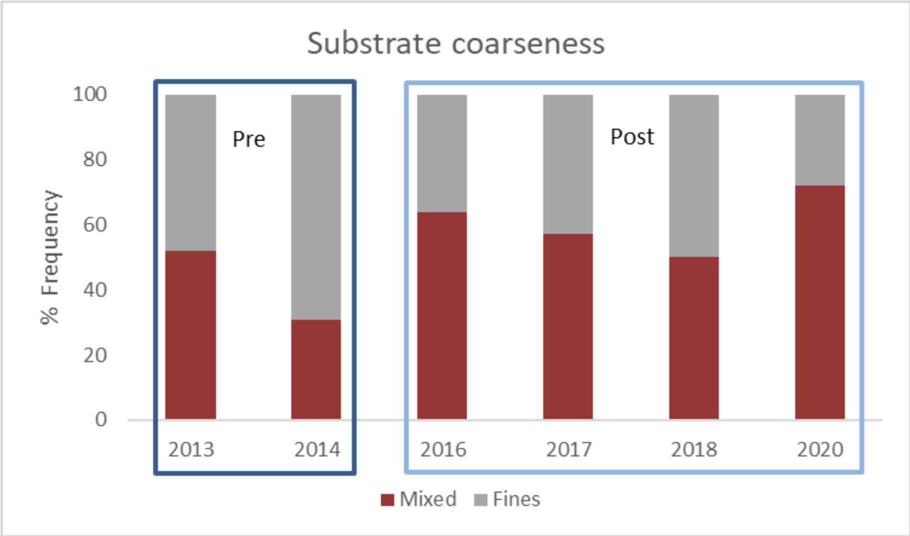


Figure 3.3 Changes in substrate coarseness pre (navy box) and post (blue box) fencing and channel maintenance.

Mean flow velocities showed a marked decline from 2013 to 2017, before recovering to a substantial increase by 2020 (Figure 3.4).

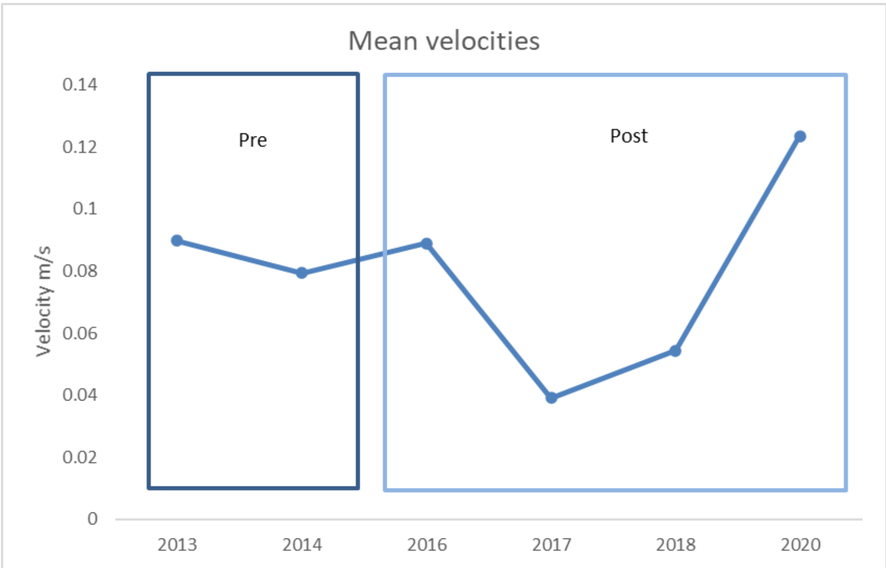


Figure 3.4 Changes in mean flow velocities pre (navy box) and post (blue box) fencing and channel maintenance.

3.3.1 Recovery trajectory

Physical recovery may be characterised as occurring in four defined periods within the present study timeframe. Period one (2013-2014) is 'disturbance' where livestock and dredging pressure maintained an artificially widened channel and retarded recovery (Figure 3.5, year: 2013). Period two (2015-2016) followed livestock exclusion and the last channel maintenance cycle from the end of 2014 onwards. Pioneer macrophyte species rapidly established in the channel and promoted greater depth, flow and substrate diversity by trapping sediment and by obstructing and deflecting flow (Figure 3.5; year: 2016). Period three (2017-18) was a lag when macrophytes filled the channel space and widely impeded flow, resulting in low flow velocities (Figure 3.5 year: 2017). In the most recent period, from 2019-2020 and onwards, the channel appears to be adjusting towards a more defined/naturalised form and this is reflected by increasing substrate coarseness and associated higher mean velocities (Figure 3.5 year: 2020).

Figure 3.5 A survey reach pre livestock exclusion/dredging in 2013 (top left), three years post in 2016 (top right), four years post in 2017 (bottom left) and seven years post in 2020 (bottom right). Channel adjustments to pressure removal are evident in 2020 from the stabilised margins and the development of a pseudo-meander form within the previously over-widened channel.

3.4 Discussion

3.4.1 Hydromorphological recovery

Recovery of channelised rivers is associated with increasing structural diversity, more natural bed material and flow regime. Our results suggest that faster flow velocities and greater substrate diversity are directly mediated by macrophyte establishment. Recovery toward a more natural hydraulic (flow and depth) regime likely occurs because establishing macrophytes block and deflect flow, leading to changes in fine-scale velocities. This process has the effect of creating a more centralised flowing channel typified by coarser substrate material. Regulation of river morphology by macrophytes occurs through a feedback mechanism between vegetation establishment, flow redistribution and the effect this has on substrate composition. Here, increases in plant cover caused a decrease in flow velocities and an associated capture and storage of finer sediment in vegetated patches. Simultaneously, flow velocity was increased by constriction in adjacent un-vegetated patches leading to patches of coarser substrate in the 'open' channel. In a feedback, patches subject to higher velocities have increased shear stress and lower sediment/nutrient availability from fine material, creating less preferable conditions for macrophyte growth (Meire *et al.*, 2014; Larsen, 2019), but more favourable environment for development of coarser substrate patches. In contrast, vegetated patches as obstacles promote aggradation of fine material and may also intercept seeds and other embryonic plant material which creates preferable conditions for plant establishment and growth (O'Hare *et al.*, 2012; Gurnell *et al.*, 2013). Correspondingly, this interaction encourages development of heterogeneous habitat that can support a greater range of species compared to artificially homogenised rivers and deserves greater attention in restoration schemes.

3.4.2 Management implications

In light of the above, the results are pertinent to the management and restoration of the study river and low gradient systems elsewhere. The most abundant plant species recorded are particularly common across OPW managed rivers. Under current maintenance programmes, abundant vegetation growth is regarded as problematic because it reduces water conveyance. Conventional management thinking for water conveyance is that low energy systems become choked with aquatic vegetation and sediment and, therefore, need to be regularly 'cleaned'. Clearing vegetation removes habitat directly, reduces physical diversity and re-suspends fine sediment which can be deleterious to stream biota (Sea *et al.*, 1995; Wood et al., 1997; Evans *et al.*, 2006). In contrast, this study provides evidence for the holistic importance of aquatic river vegetation, which improves flow regime, associated sediment flushing/storage and related habitat forming processes. Hence, in strategies that seek to balance biodiversity and human needs, there is a requirement to reconsider vegetation as a key component of river function and the ability to support a diverse range of habitats.

Actions to maintain flow conveyance by dredging reset the system to an earlier (geomorphic) phase and create homogenous low velocity flow and substrate conditions. In this low gradient system, pioneer macrophytes quickly respond to these conditions and fill the channel cross section. The channel became clogged within three years during the current study time. Under the commonly adopted maintenance cycle of five years, the system would reset, habitat lost and maintained in a retarded state. River processes arise from the interplay of vegetation, water flow, sediment and drainage in shaping channel form and its capacity to recover from hydromorphological degradation. This study supports an argument for longer periods between, and less severe maintenance activities to allow for the eco-hydromorphological processes to function. Moreover, it indicates that river maintenance within shorter time frames encourages excessive vegetation cover and associated blockages that may impede flow conveyance.

Figure 3.6 Drone imagery of Stonyford experimental Site 3 Left to right – January 2018, July 2018, July 2019 and July 2020. Showing winter conditions (January 2018) and summer growth over a 3 year period.

Altered hydromorphological form and floodplain space is one of the most pervasive constraints on river ecosystem restoration (Beechie *et al.*, 2008; Schinneger, 2012), both in terms of restoring historic structure and in meeting assumptions and expectations of process-limiting factors such as flow and succession dynamics. Anthropogenic pressures in the current study river have changed its physical parameters and the boundaries within which it can renaturalise. Despite these alterations, results indicate that the system retains capacity to self-organise and recover towards a more natural state. Following pressure mitigation, the river is developing a two-stage form as it attempts to engineer dimensions that reflect its stream power. It is evident that the vegetated margins are aggrading to form lateral berms and a pseudo-meander form is taking shape within the engineered channel dimensions (Figure 3.6).

3.5 Conclusion

In summary, this study raises important points relevant to management of OPW channels:

- Vegetation is a key component of river function and associated instream habitats
- Relatively short maintenance cycles may encourage the proliferation of excessive vegetation, ultimately reducing conveyance capacity
- Arising from the mitigation of channel pressures, the river will re-naturalise over a short time-frame

One potential management solution is that any maintenance programme is limited to the new wetted area leaving developed berms intact, in line with Environmental Drainage Maintenance procedures (Brew & Gilligan, 2019). In this event, maintenance activities retain a berm height that preserves a two-stage channel and associated habitat diversity. This two-stage design replicates natural lowland river processes to some extent, in that the base channel maintains conveyance at average discharge and floodplain connectivity is limited to the secondary channel at higher flows, providing flood protection and a degree of 'floodplain connectivity' and related habitat. Hybrid eco-engineering strategies of this nature represent a compromise approach that aims to integrate ecological and societal benefits simultaneously (Rowiński *et al.*, 2018). Adoption of similar approaches are growing in popularity and may be termed "green infrastructure'', as an adaptation strategy that considers biodiversity as integral to managing flood risk, and the social and economic costs associated with biodiversity loss (Tickner *et al.*, 2017; Nakamura *et al.*, 2020). Key issues which can be considered in the management of arterially drained channels in light of this study on the Stonyford include:

- Appropriate timing for maintenance cycles in rivers where instream vegetation proliferates
- Effective implementation of the Environmental Drainage Maintenance protocol's ten steps including berm management and selective vegetation removal
- The importance of working *with* the river's natural processes to retain diversity in channel bedforms, substrate type and flows
- Assess conveyance capacity of these stretches in light of these developments
- Whether or not conveyance changes in the upper catchment have any implications for natural flood management strategies including 'slow the flow' campaign

4 Walkovers and inter-agency collaboration

A central focus of EREP has been collaboration between the two public authorities to achieve maximum environmental gain while balancing OPW's statutory functions with regard to drainage and flood relief. To facilitate collaboration, various fora are used for on-site and off-site discussions. After March 2020, all meetings and workshops were moved to online meeting platforms. As well as regular EREP updates, progress was made in a number of areas in 2020 between the OPW Environment Section and EREP team, including data management/transfer, exploring catchment-wide RHAT results and barrier mitigation workshops. Site walkovers, a regular feature of EREP since its inception, were held in line with Covid-19 safe work practices, with limited numbers present.

The EREP team undertakes on-site walkovers every year, generally with one located in each OPW drainage scheme/district. The team aims to carry out these walkovers on river sections scheduled for arterial drainage maintenance in the upcoming work programme, so that agreed measures can be incorporated into the programme. These site visits are attended by EREP staff, OPW foreman and driver, as well as local IFI staff.

Walkovers allow for discussion on-site about practice and implementation of the Environmental Drainage Maintenance SOP including the 10 Steps to Environmentally Friendly Maintenance (Brew & Gilligan, 2019). OPW have a remit to maintain for conveyance purposes and the Environmental Drainage Maintenance SOP outlines the current best practice of how to implement that in an environmentally-friendly manner. The walkovers serve to reinforce learnings from training on same, as well as to provoke discussion on opportunities for river enhancement of fisheries habitat, following the Environmental River Enhancement SOP. Following each walkover, a plan is drafted using photographs and proposed actions discussed on the day, which is then shared with OPW staff. This collaborative approach promotes opportunities for OPW foremen/drivers to implement enhancement strategies on similar channels on their upcoming work programme.

4.1 Kilroe River (CH1) – Corrib Scheme

A walkover was completed in November 2019, with attendees from IFI including the EREP team and regional colleagues, along with OPW arterial drainage maintenance staff. The aim of the walkover was to make maintenance recommendations on the Kilroe River (CH1) using the 10 Steps to Environmentally Friendly Maintenance developed by OPW and IFI (Brew & Gilligan, 2019) as part of the Environmental Drainage Maintenance procedures.

This channel is located South East of Headford and is part of the OPW Corrib Headford Scheme, with drainage works completed historically between 1967-73. This channel was scheduled for maintenance works in 2020. The entire channel is 6km in length and drains directly into the Lough Corrib (Figure 4.1). Approximately 2.5km was walked on the day.

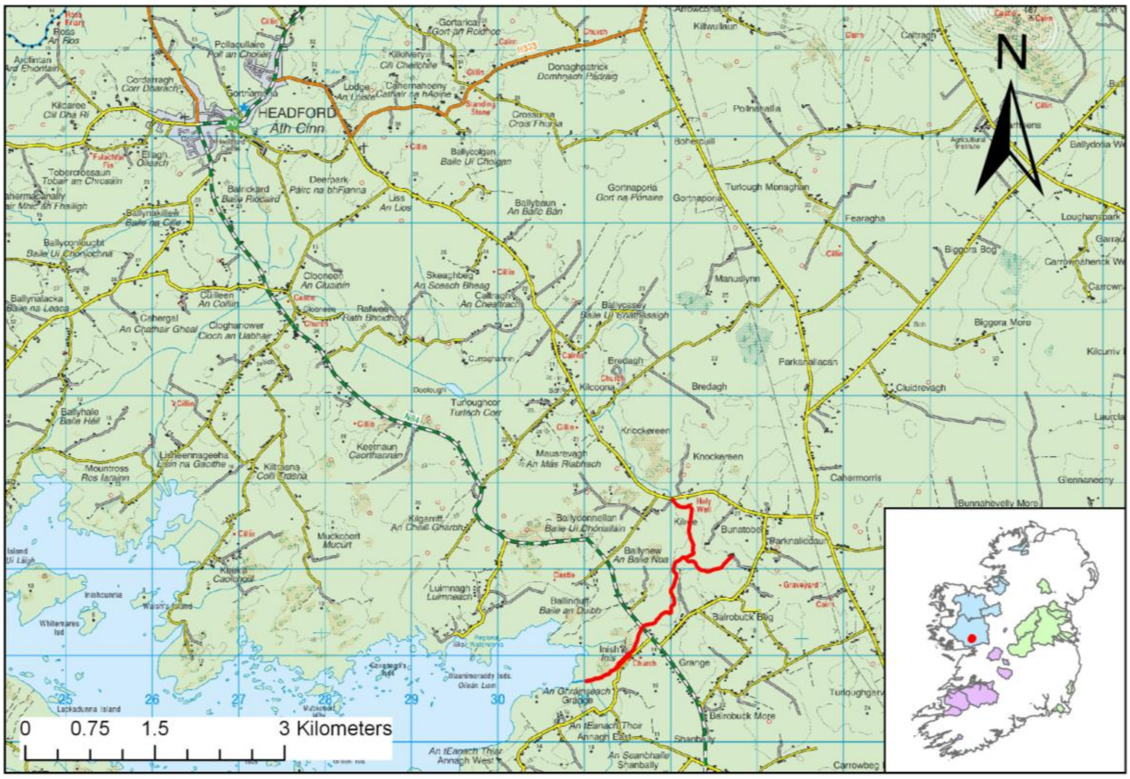


Figure 4.1 Map showing location of channel CH1 (red line) in relation to Headford, Co. Galway.

The walkover identified scope to implement a range of elements from the 10-point environmental maintenance guidance along with trialing new opportunities identified by IFI Western RBD and OPW. These steps included Tree Management (S6); Over–Deepening (S10); Topping of Berms (S7); Leave sections untouched (S5); Loosen bed gravels (S9); Restrict maintenance to channel (S2); Minimal vegetation removal (S4). Closing off cattle drinks using soft engineering works as well as installation of fencing were agreed as Capital

Works within this specific EREP study. The instream work was halted during 2020 and is due to proceed in 2021.

Fencing was provided for the educational site using capital works funding under the EREP (Figure 4.2). The entire field was fenced along the bank top comprising 270m fencing in total erected. Stiles were also included for enabling ease of access to the site. Seven step-out enclosures were necessary around the tree plantations/clusters planted as part of the project, to prevent livestock destroying the vulnerable newly planted trees.

The types of trees selected include hawthorn, hazel, oak, rowan, alder, birch, scots pine and apple trees. The location of plantations alternated between both left- and right-hand banks. A restricted area on the plantations ensures that the trees planted on the OPW working bank will not hinder their access to the channel during future maintenance.

Figure 4.2 Entire stretch of channel walked was divided into sections. Section 2a (Educational Site) is area in discussion below.

In December, the final stage of tree planting in the Kilroe River took place (Figure 4.3). The trees were funded and sponsored by Ballindiff Anglers from “Trees on the Land” and McGuaghs Garden Centre and consisted of a mix of Irish fruit trees and native species. Ballindiff Anglers, IFI WRBD staff and the local community supported by the landowner carried out the planting of the trees.

This project aims to improve biodiversity along the Kilroe river as well as educating school children from two local primary schools about enhancing their local river. The students can become stewards of their local river and help safeguard this resource for future generations.

Stage two of the project will take place in 2021 when bird nesting boxes will be installed at another site (Section 3) by Annaghdown Anglers with help from their local national school. It is hoped that when restrictions allow, the local schools will be able to visit the sites and take part in an outdoor classroom about the project.

Figure 4.3 Photo of the tree planting day in December 2020.

This project is a positive example of stakeholder engagement and interactions, generating co-operation among a number of different stakeholder groups. Moreover, it fits in with high-level objectives for stakeholder engagement within IFI’s corporate plan. On-site activities educate the young people involved and emphasises the importance of riparian flora and fauna and their interactions within the river corridor.

4.2 Ballaghnatrillick River (C1/8) – Duff Scheme

The Ballaghnatrillick River is located south of Bundoran, Co. Donegal (Figure 4.4) and is a major tributary of the Duff River. Drainage works were completed on the Duff Scheme between 1963-65. A walkover was completed in July 2020 with attendees from local OPW offices and EREP team members.

Advice was given on the implementation and best practice of the 10 Steps to Environmentally Friendly Maintenance (Brew & Gilligan, 2019). Instream vegetation was minimal and as expected for this channel, as it has higher gradient in places compared to other drained channels. The main area of focus here was blockage removal to improve flood conveyance. Over the 2km of channel walked 19 work sites were identified (Figure 4.4)

The main steps which were mostly flagged and discussed during this walkover was Steps 2, 5, 6, 7 & 10. Restricting maintenance and leaving sections untouched was recommended at 7 sites along the entire stretch as well as locations between work sites to remain untouched. Minimal berm management was recommended at 4 sites in the hope to combat further erosion to the opposite banks resulting in loss of farmland. Tree management/ blockage removal was required at 7 sites in total. Reprofiling the riverbed by creating and encouraging the development of pools and riffles was advised at 3 of these sites.

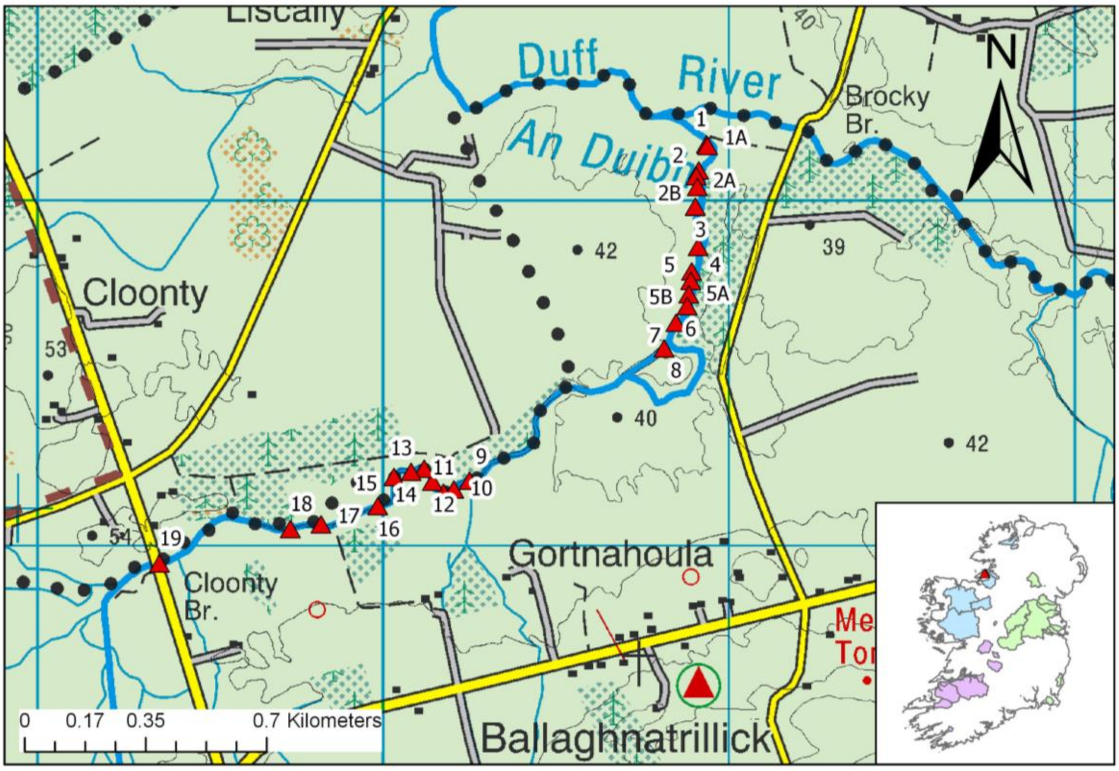


Figure 4.4 Map showing photo locations from July walkover on channel C1/8 (red triangles).

Figure 4.5 Photo of blockage in channel which will impede flood conveyance.

Drivers encouraged to practice Step 6 here (**Figure 4.5**).

The tree branches located in the middle of the channel obstruct flows and are problematic for flood conveyance. These branches are likely to catch other woody material being transported by the river and over time create a larger obstruction. For this scenario drivers were advised to remove only a percentage of the stump and tree branches so that the pool and habitat which had developed behind this obstruction could remain. A variety of habitat forms provide resting and shelter areas for fish species and so it is important that these stay intact.

Step 10 was encouraged at this site.

It was considered that the existing riffle (Figure 4.6) would remain, and a pool directly upstream would be over-deepened. Again, providing different forms of habitat to support an array of fish species of different age classes.

Figure 4.6 Pool and riffle naturally present at this site.

Advice given here was to retain the central gravel shoal (Figure 4.7) which had developed naturally here (Step 5). The staff were also advised to leave woody debris visible on left hand bank as it was not obstructing flood flow but is beneficially directing flows downstream and causing no issues with bank stability on the opposite side.

Figure 4.7 Evidence of natural features present – in this case a gravel shoal.

4.3 Mountain Water (C1/3) – Blackwater Scheme

This walkover was completed in December 2020. Attendees ranged from a variety of public bodies including OPW, LawPro and IFI staff from EREP and the Catchment CARE project. In total 16 sites along the channel were discussed in a 1.3km stretch (Figure 4.8).

The main steps encouraged and discussed during this walk over was Steps 2, 5, 6, 7 & 10. Areas located between photo locations (red triangles) were to be left untouched and no maintenance works to be undertaken. Tree management and blockage removal was advised at 11 sites, with berm management discussed at 1 site and digging of pools & riffles were advised at 6 sites. Reprofiling of the channel bed to form new pools and riffles will be subject to bed material and discussed further when the works commence.

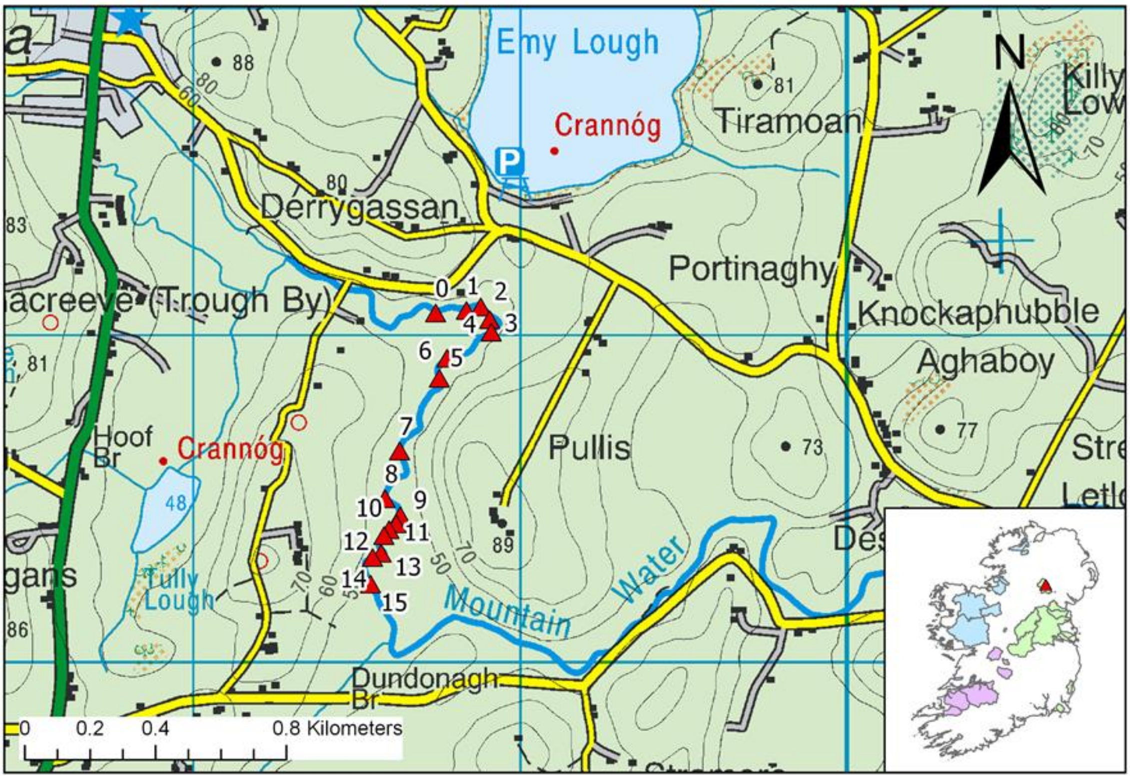


Figure 4.8 Location (red triangles) of walkover completed on the Mountain Water in the Monaghan Blackwater Catchment just South of Emy Lough.

This blockage is problematic and an obstacle for flood conveyance (Figure 4.9). Practice of Step 6 was advised here.

It was decided the best approach to fix this problem in an environmentally friendly way was to remove all the dead material completely and trim all live branches within 45-degree angle to surface of the water.

This in turn fixed the conveyance issue, and reduced the chance of build-up occurring again as water levels fluctuate. This also retains canopy cover which is important along the bank for fish and other fauna.

Figure 4.9 Photo of blockage in channel which will impede flood conveyance.

4.4 RHAT document

The EREP team have been undertaking RHAT surveys on a catchment-wide scale since 2015, and before that on a site-specific scale where enhancement measures were planned. Following compilation of catchment-wide results in last year's EREP annual report (Fleming *et al.,* 2020), OPW identified a need for more specific information with regards to the application of the 10-step environmental guidance (Brew & Gilligan, 2019) to improve RHAT outcomes. Following this, it was agreed that the EREP would generate a document for internal use by the Environment Section with examples of RHAT surveys and a range of descriptors outlining the rationale for scoring. The purpose of the document is to be a visual guide for providing understanding and interpretation of RHAT results, while encouraging application of the 10 steps to address deficiencies in the RHAT score (Figure 4.10).

5. Bank Structure & Stability

(PRG) Cormey River, Glyde catchment, Co. Cavan – High

Attribute Score – LHB 2 (High) & RHB 2 (High)
both banks are in their natural condition. There is evidence of undercutting and eroding which is a natural process for this river type. Tree growth extends to bank top stabilising banks in places. Banks have not been modified or re-sectioned.

Step 5 – *Leave sections untouched.*

(PRG) Glore River, Inny catchment, Co. Westmeath – Bad

Attribute Score – LHB 0.5 (Poor) & RHB 0 (Bad)
River is re-sectioned entire length on both banks.
It has a trapezoidal shape with uniform vegetation and no trees, which assist in stabilising the banks.
Unstable banks will be prone to erosion particularly during spate flows.

Steps 1, 2 & 4 – *Protect both bank slopes by allowing marginal vegetation to colonise. This protects banks from erosion. Fencing and tree planting creating a buffer zone on both banks would aid stability. Restrict maintenance to channel.*

Figure 4.10 Example of RHAT attribute with interpretation and possible applied measures.

Of the eight RHAT attributes, there is scope for improvement in five via effective application of the 10 steps by those involved in implementing arterial drainage maintenance:

- Channel form and flow type (steps, 4,7,8,10)
- Channel vegetation (steps 2,4,5)

- Substrate condition (steps 2, 3, 8, 9, 10)
- Bank structure and stability (steps 1, 2, 4, 5, 6)
- Bank vegetation (steps 1, 2, 5, 6)

Moreover, a sixth attribute ‘Barriers to Continuity’ is being addressed separately by OPW Environment Section and IFI through workshops and a planned pilot scheme. The remaining two components ‘Riparian land cover’ and ‘Floodplain connectivity’ are largely unmodifiable except by shifts in national-scale policy which could enable change.

The document was distributed to the Environment Section with positive feedback. It is planned to build more on this understanding in the 2021 field season through planned walkovers between IFI and OPW on sites with variable RHAT scores to put these learnings into context. Optimal and widespread application of the 10-steps by arterial drainage maintenance staff has the potential to improve individual attribute scores, which in turn influence the overall RHAT Scores of the reach.

5 Going forward – development of EREP in 2021

As the worldwide pandemic unfolded in 2020, work plans were altered in line with safe practices of work, adhering to standard operating procedures developed according to public health guidelines. From an EREP perspective, the schedule of field work for the year was adapted accordingly, with a focus on completing feasible survey work that was geographically closer to HQ. This meant that day trips to and from HQ were reduced in length and resulted in an overall safer working environment for project personnel. Some elements which had been in the 2020 field work plan were not completed during the shorter field season. Varying Covid-19 restrictions and absence of safe systems of work for some survey methods contributed to these changing priorities.

The agreed focus between IFI and OPW for WFD-compatible outcomes in terms of RHAT scores and Ecological Quality Ratios was fulfilled in the Glyde catchment in lieu of the Kells Blackwater, which had been in the initial 2020 work plan. The smaller catchment size enabled the entire catchment-wide survey to be completed within what was a shorter than usual field season. The outcomes from the completion of the barrier survey in the Glyde catchment feed into the National Barrier Programme geodatabase cataloging problematic structures to fish migration. Similarly, work completed by the NBP and other IFI teams during 2020 generated barrier data on other catchments within OPW's remit, including various subcatchments of the Boyne, which will be shared with OPW. This co-operation between teams represents efficient use of resources and it will continue into 2021 enabling further coverage of the dense network of structures evident in OPW schemes.

In 2021, it is realistic to assume that restrictions could again play a part in adapting priorities for the field plan as the year progresses. At the beginning of the year, the schedule incorporates the Kells Blackwater as the focus for the catchment-wide survey. Long-term studies are pencilled in for the Rivers Dee and Deel. A pilot study will be initiated examining instream canopy cover and thermal impacts. Following discussion with OPW throughout 2020, there is a renewed focus on catchment-wide RHAT results and the scope for arterial drainage maintenance practices to positively influence RHAT outcomes. Efforts will be made to streamline data collection into a mobile web-mapping application, enabling quicker data compilation and analysis. Walkovers will continue in 2021, with input not just from the two public authorities involved in the EREP, but also LawPro, where waterbodies of interest are overlapping with their priority areas for action. Specific walkovers with the OPW Environment Section will highlight areas of hydromorphology which have the potential for improvement with optimal application of the Environmental Drainage Maintenance procedures.

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