Wicklow Bridges Project

Assessment of the risk of barriers to migration of fish species in County Wicklow

Report to Wicklow Heritage Forum

Inland Fisheries Ireland
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1. Introduction

Project Overview

To carry out an ecological survey of a selection of Culverts and Bridges in the County for which there are most likely to be fish/mammal passage problems or other impediments for wildlife.

As part of the survey draw up recommended mitigation, and/or biodiversity enhancement measures.

1.1 Project Context

The project was coordinated by Wicklow County Council, through the Wicklow Heritage Forum and was part funded by the Heritage Council of Ireland. Three project partners - Inland Fisheries Ireland (IFI), The National Parks and Wildlife Service (NPWS) and Birdwatch Ireland contributed to the project. The County Wicklow Heritage Plan 2009 – 2014 forms the background to the project (a partnership plan, prepared by the Wicklow Heritage Forum), within which, Heritage Plan Action: 3.8 was to *Undertake a survey of bridges and relevant culverts in County Wicklow to identify fauna usage and assess whether any impediments to passage exist, particularly in light of ongoing changes in climate and rainfall patterns etc. Use this information to carry out retrofitting of features such as nest boxes, fish baffles and mammal ledges wherever possible.*

1.2 The role of project partners

Inland Fisheries Ireland assessed the level of risk to fish migration associated with 103 watercourse crossings (bridge/culvert/barrier sites throughout the County). Birdwatch Ireland concentrated on the usage of bridge sites by nesting birds (specifically dippers and grey wagtails). NPWS's main interest in the project related to the usage of bridge sites by bats and how the populations of other species (mainly otters) might be negatively impacted by such watercourse crossings.

In addition to fish migration risk assessment, IFI endeavoured to record the presence or absence of suitable bird or bat nesting and roosting potential and highlighted the absence of mammal passes at numerous bridge and culvert sites on busy roads.

1.3 Barriers to fish passage

The Habitats Directive (CEC, 1992) and the Water Framework Directive (WFD) (CEC, 2000) have direct relevance to the existence of artificial barriers in river systems. Under Article 5 (1) of the WFD there is a requirement for Member States to carry out, for each River Basin District, "a review of the impact of human activity on the status of surface waters and groundwaters". The identification of significant morphological alterations (such as the construction of in-river barriers) to waterbodies is listed in Annex II of the WFD as a specific pressure which had to be addressed in the risk assessment. Gargan et al., (2011) comment that the WFD "*considers ecological quality in the context of a range of biological elements, including fish community composition and age structure, and of physical elements, including hydro-morphology. The WFD anticipates that restoration of 'high' and 'good' water quality would include hydro-morphological continuity, to ensure that the continuity of the river is not disturbed by anthropogenic activities and that the undisturbed migration of aquatic organisms and sediment transport can occur*...*In Ireland, the Water Framework Directive Freshwater Morphology Programme of Measures and Standards identified barriers to fish migration as one of the principal issues placing channels "at risk" in terms of failing to achieve good or high status as required under WFD*".

The Habitats Directive identifies a number of fish species, for which member states must designate Special Areas for Conservation (SACs) in order to ensure the conservation status of the listed species" (Gargan et al. 2011). Fish species listed in Annex II of the Habitats Directive include Atlantic Salmon (*Salmo salar*), Sea lamprey (*Petromyzon marinus*), River Lamprey (*Lampetra fluviatilis*) and Brook Lamprey (*Lampetra planeri*), all of which with the exception of Brook lamprey are diadromous (travel between the sea and freshwater).

Because these species migrate over large distances in rivers; they will inevitably encounter barriers to free movement. European eel (*Anguilla anguilla* - another diadromous species) is not listed in the Habitats Directive. However, current eel stocks are outside safe biological limits. This has led to the introduction of the EU Eel Regulations (Council Regulation 1100/2007) which requires Member States to establish eel management plans.

1.5 Fish life history – migratory species

Many fish species undertake extended migrations as part of their basic behaviour. The best known example in Ireland is the Atlantic salmon (*Salmo salar*). Other species likely to be encountered in Ireland which undertake extended migrations include the Sea trout (Salmo trutta), River lamprey (*Lampetra fluviatilis*), Sea lamprey (*Petromyzon marinus*) and the European eel (*Anguilla anguilla*). In addition to the species listed above, within rivers resident fish populations undertake local migrations from one area to another at certain times.

1.5.1 County Wicklow's Migratory Fish species

Lamprey

Three species of lamprey are found in Wicklow's inland surface waters, Sea Lamprey (*Petromyzon marinus*), River Lamprey (*Lampetra fluviatilis*) and Brook Lamprey (*Lampetra planeri*). Both Sea Lamprey and River Lamprey are anadromous (adults returning to fresh waters from the marine environment to spawn), while brook lamprey are a purely freshwater species. All three species are listed in Annexes II and V of the Habitats Directive. All three species of Lamprey are regarded as "weak" swimmers rendering their migration and associated spatial distribution especially vulnerable to the presence of in-stream impediments. "In Ireland the single biggest factor limiting the distribution of anadromous lamprey are upstream barriers" (Igoe et al., 2004).

European Eel (*Anguilla anguilla*)

The National Report for Ireland on Eel Stock Recovery Plans published by the Department of Communications, Energy and Natural Resources in December 2008 states that "The latest scientific advice from the International Council for the Exploration of the Sea (ICES) concerning European Eel is that the stock is outside safe biological limits and that current fisheries are not sustainable. In order that eel recovery measures are effective and equitable, it is necessary that member states identify the measures they intend to take and the areas to be covered, Ireland has fully engaged with the process of developing an EU Regulation for the Recovery of the Eel stock....Obstacles to migration in river systems are one of several factors causing the dramatic decline in the eel population, Barriers impede eels from colonizing large parts of catchments, thus reducing upstream density and the additional production of larger more fecund spawners" (Anon., 2008a). Eel reproduction takes place in the marine environment, "presumably the Sargasso sea, where the smallest larvae have been found. Larvae (Leptocephali) of progressively larger size are found as one moves from the Sargasso sea to the European continental shelf." (Dekker, 2008). Juvenile eels migrate to inshore coastal waters, estuaries and to freshwater, following which the prolonged yellow eel stage begins which may last for 20 years. Yellow eels may occupy freshwater or inshore marine and estuarine areas. At the end of the continental growing period, eel start maturing and return from inland and coastal waters to the Atlantic Ocean to spawn. The juvenile eels migrating upstream through freshwater systems are very small at 60-100mm in length and have low swimming performances compared to salmonids. Poole (2010), states that eels are incapable of jumping, or swimming through strong laminar flows, so vertical falls of more than 50% of their body length (an elver is approximately 75mm in length) represent a barrier to upstream migration.

Atlantic salmon

"The Atlantic Salmon (*Salmo salar*) is listed in Annexes II and V of the European Union's Habitats Directive as a species of European importance. Historically, the species was widely distributed in all countries whose rivers enter the North Atlantic. However, the Atlantic salmon's current distribution has been restricted by anthropogenic effects, including man-made barriers to movement and deterioration in water quality due to urban expansion and changes in agricultural practices" (Hendry & Cragg-Hine, 2003). "The salmon population in Ireland has declined by 75% in recent years and although salmon still occur in 148 Irish rivers, only 43 of these have healthy populations" (Anon., 2008b).

Brown trout and Sea trout

Brown trout (*Salmo trutta*) are ubiquitous in rivers throughout the area surveyed under this project. "Sea trout (*Salmo trutta*) are anadromous forms of the Brown trout that spend periods of their life feeding at sea before returning their natal rivers to spawn. The parents of such fish can, themselves be anadromous or freshwater brown trout or, a mixture of both forms" (O'Grady et al., 2008). Sea trout (like Atlantic salmon) undertake extended migrations, while resident trout will undertake small-scale migrations from one part of the river to another at certain phases of their life cycle. Brown trout are regarded as "strong" swimmers. The ability of this species to migrate will be restricted by the same anthropogenic effects relevant to Atlantic salmon described above, in particular the presence of man-made barriers to free movement.

1.6 Historical Fish data for County Wicklow and the current risk assessment exercise

It should be highlighted that the current project endeavoured to assign a risk category (high, moderate or low) to each structure surveyed for each fish species of interest. Whilst a 'high' risk score indicates the presence of a significant impediment to fish passage; it may not mean that the structure represents a complete blockage to upstream fish movement. A catchment wide electro-fishing survey of the Avoca system (Doyle et al., 2003) undertaken in 2002 illustrates this point. The results of this survey programme confirmed the presence of Atlantic salmon throughout most of the Avonmore, Avonbeg, Aughrim, Derry Water and Ow catchments despite the fact that the current study recorded the entire Ow and Derry water catchments as subject to 'high risk' barriers (because of the presence of a large weir across the Aughrim River a short distance of Aughrim). IFI are aware that salmon can ascend the weir during high rainfall events when the river is in flood. It is likely that this barrier significantly delays the migration of these fish with increased likelihood of predation and also of injury or egg loss while attempting to ascend the structure. The catchment wide electrofishing programme undertaken throughout the Avoca catchment did confirm the complete absence of juvenile salmon on a number of tributaries upstream of impediments to fish passage, including the Macreddin/Ballycreen Brook and the Goldmine River.

2. Methodology

2.1 Site Selection
Assessments were undertaken on the majority of river systems in County Wicklow including the Avoca, Slaney, Dargle, Liffey, Vartry, Potters, Redcross and Three Mile Water (Figure 1). Inland Fisheries Ireland staff, were aware of a number of bridge crossings in the County which represent full or partial barriers to fish passage. Priority was given to these sites in the current study. The majority of bridge and culvert sites assessed were located on national and non-national roads. Other sites assessed included watercourse crossings on private roads, farm roadways, forest roadways and railway crossings. A small number of weir and dam sites were also assessed.

2.2 Field Data Collection
A total of 103 sites were assessed for risk posed to upstream movement of a number of fish species using a standardised IFI assessment sheet. Data was collected for each site under the following headings (see Figures 2 & 3 for example of field sheet):

- General information including location
- Nature of obstruction
- Construction material type
- Roughness
- Obstruction specification
- Pipe or culvert obstruction
- Edge or fringe effects - (a part of the obstruction, usually at peripheral locations, where easier conditions exist for fish to pass). Particular relevance to eels and lamprey
- Presence of fish pass
- Risk of passage to fish species
- River conditions during survey
- Other relevant details
- Photographs of the structure

Once all data was collected, an assessment was made on-site by the surveyor regarding the risk of the structure impacting on the migration of Atlantic salmon, Brown trout, Lamprey, Eel and other species. Risk categories were assigned for each species as follows:

- Low Risk
- Moderate Risk
- High Risk

The survey work included measurements of the width, length and height of the various structures. Photographs were taken of the structure from different aspects and angles to produce a photo record catalogue of more than 600 images. Materials used were limited to a GPS unit, staff gauge, tape measure and camera. Such survey work is best carried out by a minimum of two people. A number of the sites were surveyed using a tablet device which contained a digitised version of the IFI barrier form. The tablet device included a GPS unit and camera. The data and photos relating to all sites surveyed were inputted into the tablet device, which will facilitate the transposition of all data into a national IFI geodatabase.

Please note a full record of all data recorded during site assessments (including photographs) will be available in an appendix to this report.

2.3 Mapping
All data was geo-referenced in the IFI GIS and a geodatabase was produced which contains all site specific data. This geodatabase will facilitate spatial querying and analysis relating to the 103 structures surveyed.

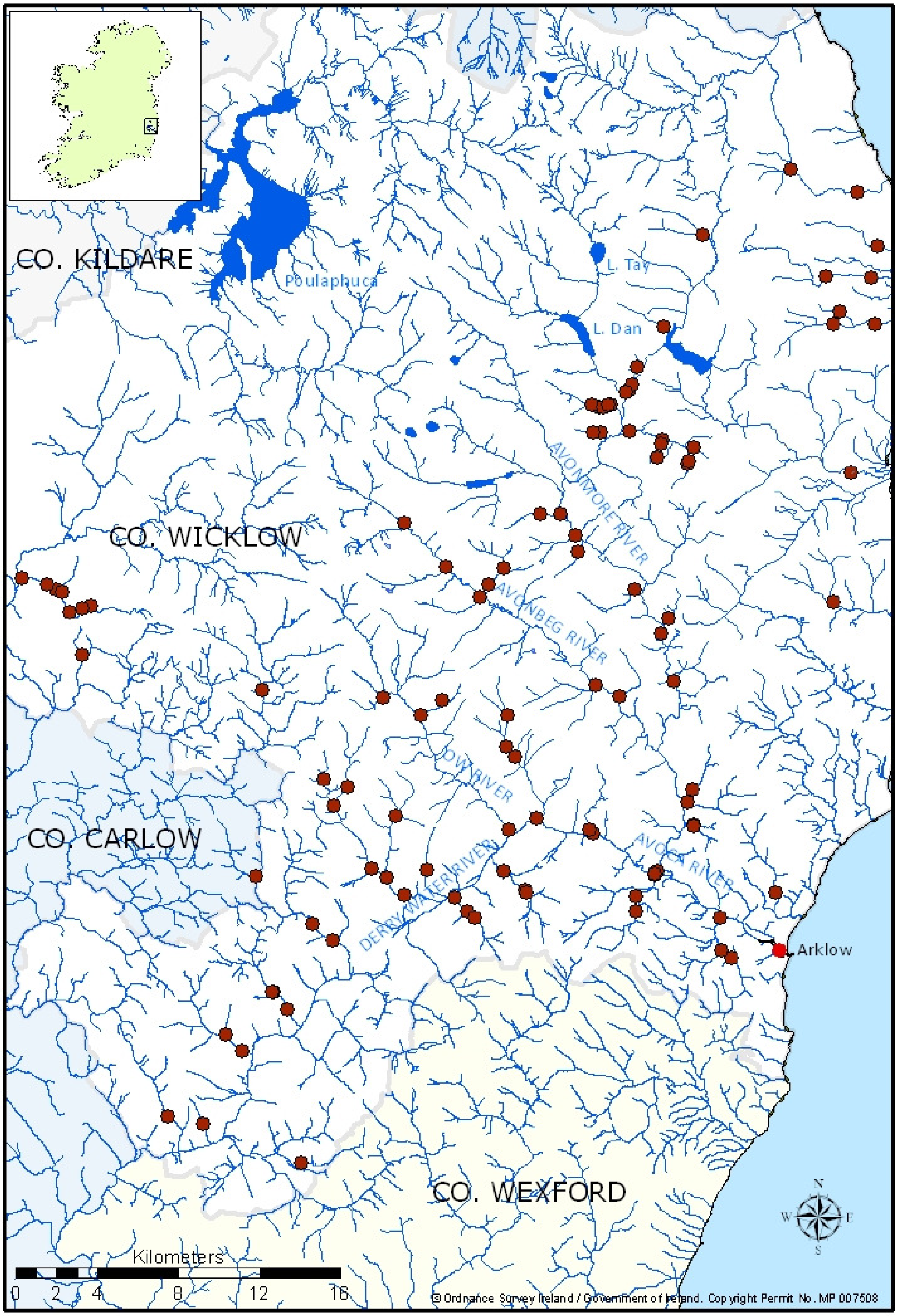
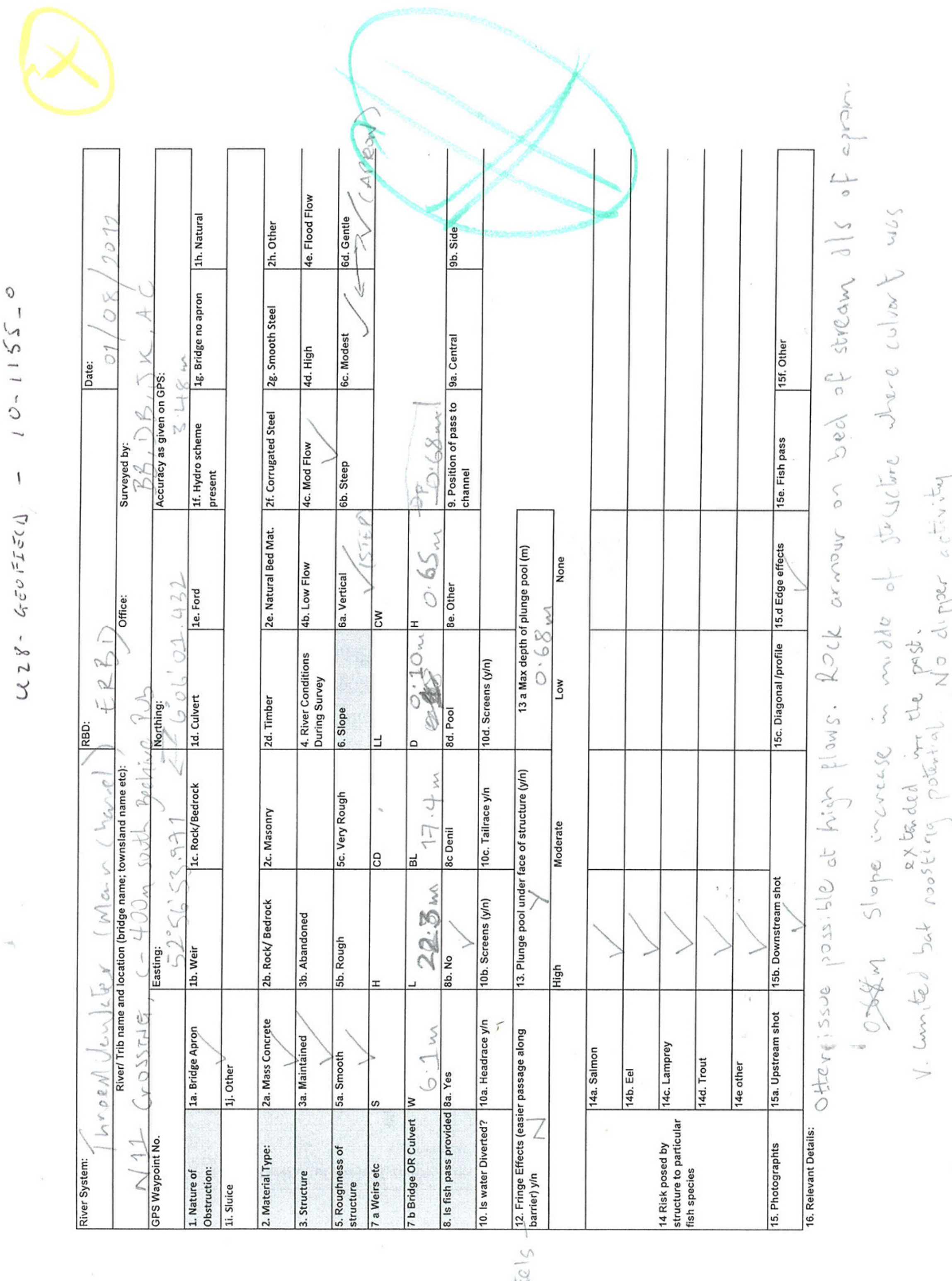


Figure 1. Map of sites surveyed by Inland Fisheries Ireland for the Wicklow Bridges Project.


U28- GEOFIELD - 10-1155_0

River System: Threemilewater (Main Channel) | RBD: ERBD | Date: 01/08/2012
River/ Trib name and location (bridge name; townsland name etc): N11 Crossing, c-400m south Beehive Pub | Office: | Surveyed by: BB, DB, JK, AC
GPS Waypoint No. | Easting: 52°56'53.971 | Northing: 6°06'01.432 | Accuracy as given on GPS: 3.48m
1. Nature of Obstruction: 1a. Bridge Apron ✓ | 1b. Weir | 1c. Rock/Bedrock | 1d. Culvert | 1e. Ford | 1f. Hydro scheme present | 1g. Bridge no apron | 1h. Natural
1i. Sluice | 1j. Other
2. Material Type: 2a. Mass Concrete ✓ | 2b. Rock/ Bedrock | 2c. Masonry | 2d. Timber | 2e. Natural Bed Mat. | 2f. Corrugated Steel | 2g. Smooth Steel | 2h. Other
3. Structure: 3a. Maintained ✓ | 3b. Abandoned | 4. River Conditions During Survey: 4b. Low Flow | 4c. Mod Flow ✓ | 4d. High | 4e. Flood Flow
5. Roughness of structure: 5a. Smooth ✓ | 5b. Rough | 5c. Very Rough | 6. Slope: 6a. Vertical ✓ (STEP) | 6b. Steep | 6c. Modest ✓ | 6d. Gentle ✓ (APRON)
7 a Weirs etc: S | H | CD | LL | CW
7 b Bridge OR Culvert: W 6.1m | L 22.3m | BL 17.4m | D 0.10m | H 0.65m | DP 0.68m
8. Is fish pass provided: 8a. Yes | 8b. No ✓ | 8c Denil | 8d. Pool | 8e. Other | 9. Position of pass to channel: 9a. Central | 9b. Side
10. Is water Diverted?: 10a. Headrace y/n | 10b. Screens (y/n) | 10c. Tailrace y/n | 10d. Screens (y/n)
12. Fringe Effects (easier passage along barrier) y/n: N (Eels) | 13. Plunge pool under face of structure (y/n): Y | 13 a Max depth of plunge pool (m): 0.68m
14 Risk posed by structure to particular fish species: High | Moderate | Low | None
14a. Salmon ✓ High
14b. Eel ✓ High
14c. Lamprey ✓ High
14d. Trout ✓ High
14e other ✓ High
15. Photographs: 15a. Upstream shot | 15b. Downstream shot ✓ | 15c. Diagonal /profile | 15.d Edge effects ✓ | 15e. Fish pass | 15f. Other
16. Relevant Details: Otter issue possible at high flows. Rock armour on bed of stream d/s of apron. 0.68m Slope increase in middle of structure where culvert was extended in the past. V. limited bat roosting potential. No dipper activity

Figure 2. Completed standardised IFI barrier form for Threemilewater N11 crossing. (See Figure 10 for photograph of this bridge site)

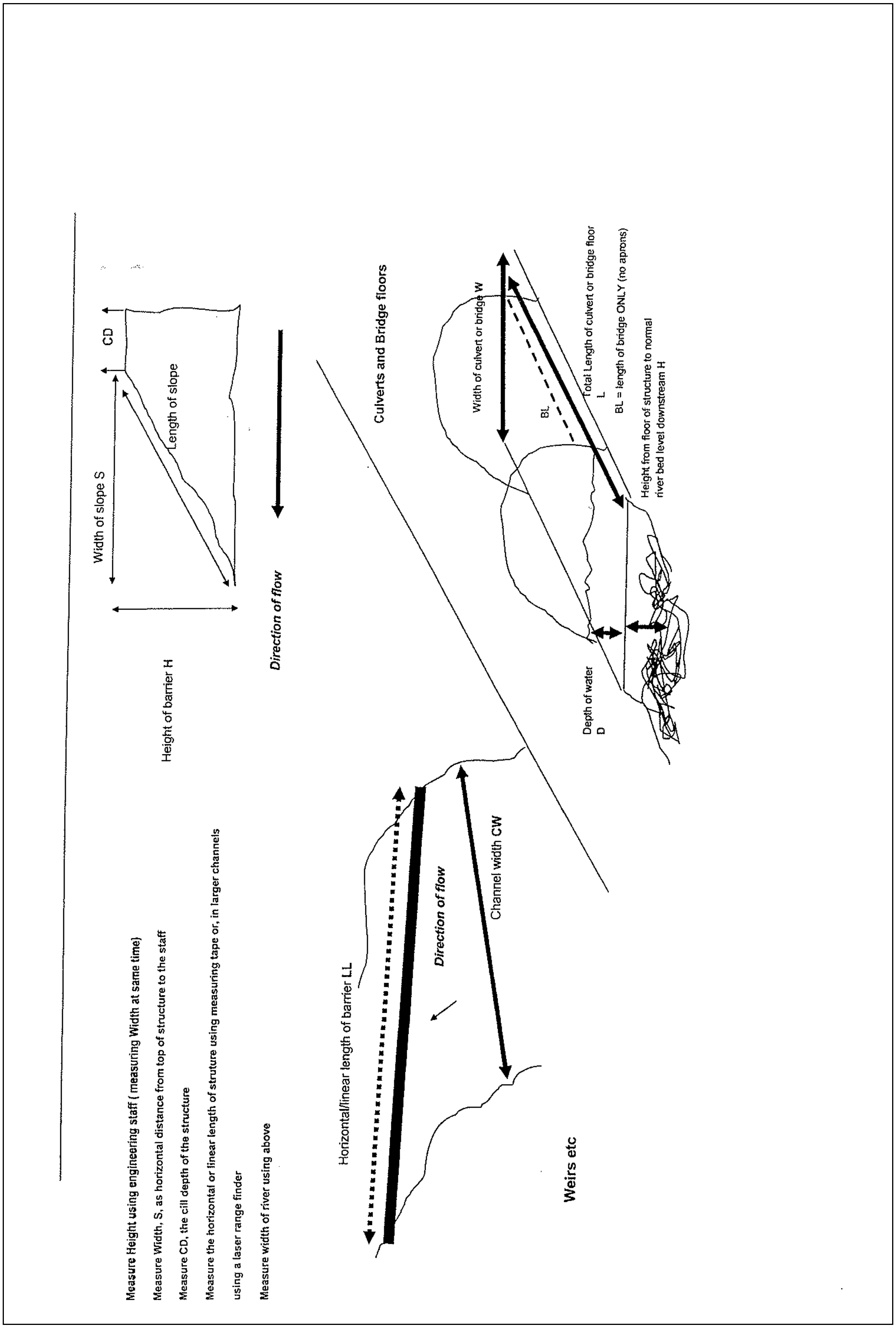


Figure 3. Explanatory diagram relating to standardised IFI barrier form

3. Results

3.1 Main Findings of the Study

A total of 103 structures were surveyed and assessed for risk posed to upstream fish movement. The main findings of the study can be summarised as follows:

- **Of the 103 structures assessed:**
  - **58 were ranked as being 'HIGH RISK' to salmonid species (i.e. Atlantic salmon, Brown trout)**
  - **12 were ranked as being 'MODERATE RISK' and 32 were ranked as being 'LOW RISK' to Atlantic salmon movement.**
  - **68 were ranked as 'HIGH RISK' for Lamprey and Eel**
- **The majority of problems related to scour apron structures**
- **At most sites the dominant 'barrier' issue was a function of a number of associated physical factors including:**
  - **Water velocity**
  - **Barrier height**
  - **Laminar flow (smooth, unbroken, sheer flow)**
- **The channels identified as being most impacted by structures included the Ballyduff Stream, the Goldmine River, the Ballycreen Brook, the Glendasan River, the Ballinglen River, the Aughrim River and numerous smaller tributaries of the Avoca system (Figure 4). A large number of significant impediments to fish passage were also recorded throughout the Tuckmill Stream located in the headwaters of the Slaney system.**
- **A significant proportion of the fish spawning and nursery habitat potential upstream of 'high risk' structures is likely to remain unrealised without intervention.**

3.2 Risk Data

Risk assessment identified numerous impediments to fish passage on watercourses throughout County Wicklow. Fish transition in the Avoca system appears to be particularly impaired, with significant impediments to fish passage recorded on numerous tributaries. A significant proportion of the Atlantic salmon and Sea trout spawning and nursery habitat of the entire Avoca system is not accessible or accessible in a limited way to these, and to the other fish species (see Figure 4). Species specific risk data is summarised in Table 1.

Table 1. Summary of risk assessment data. (Figures 5 to 8 present this data in map format)

Inland Fisheries Ireland Barrier Risk Allocation – Co. Wicklow Rivers				
	Atlantic salmon	**Brown trout**	**Lamprey species**	**European eel**
HIGH RISK	58	60	69	68
MODERATE RISK	12	10	11	12
LOW RISK	33	33	24	24

3.3 Barrier Characteristics

Table 2 and 3 present the total number of barriers separated into five categories – bridge apron, bridge (no apron), culvert, ford and weir. For each structure the number of sites categorised as high, moderate and low risk for all species are presented in Table 2.

Table 2. Barrier Risk by Structure Type.

Barrier Risk By Structure Type				
Crossing type	**Total number of sites**	**Number of sites deemed HIGH risk to all species**	**Number of sites deemed MODERATE risk to all species**	**Number of sites deemed LOW risk to all species**
Bridge Apron	**50**	32	1	6
Bridge (no apron)	**12**	1	-	9
Culvert	**31**	23	1	7
Ford	**5**	1	1	1
Weir	**5**	4	-	-

Table 3. A selection of characteristics relevant to fish passage recorded for all structures.

Selected Physical Barrier Characteristics								
Crossing type	**Total number of sites**	**Roughness of structure**			**Slope of structure**			
		# sites with smooth base	**# sites with rough base**	**# sites with very rough base**	**# sites with GENTLE slope**	**# sites with MODERATE slope**	**# sites with STEEP slope**	**# sites with VERTICAL slope**
Bridge Apron	**50**	47	3	-	16	9	2	23
Bridge (no apron)	**12**	12	-	-	10	1	-	1
Culvert	**31**	31	-	-	22	2	-	7
Ford	**5**	3	2	-	3	1	-	1
Weir	**5**	2	2	1	-	-	3	2

Please note a full record of all data recorded during site assessments (including photographs) will be available in an appendix to this report.

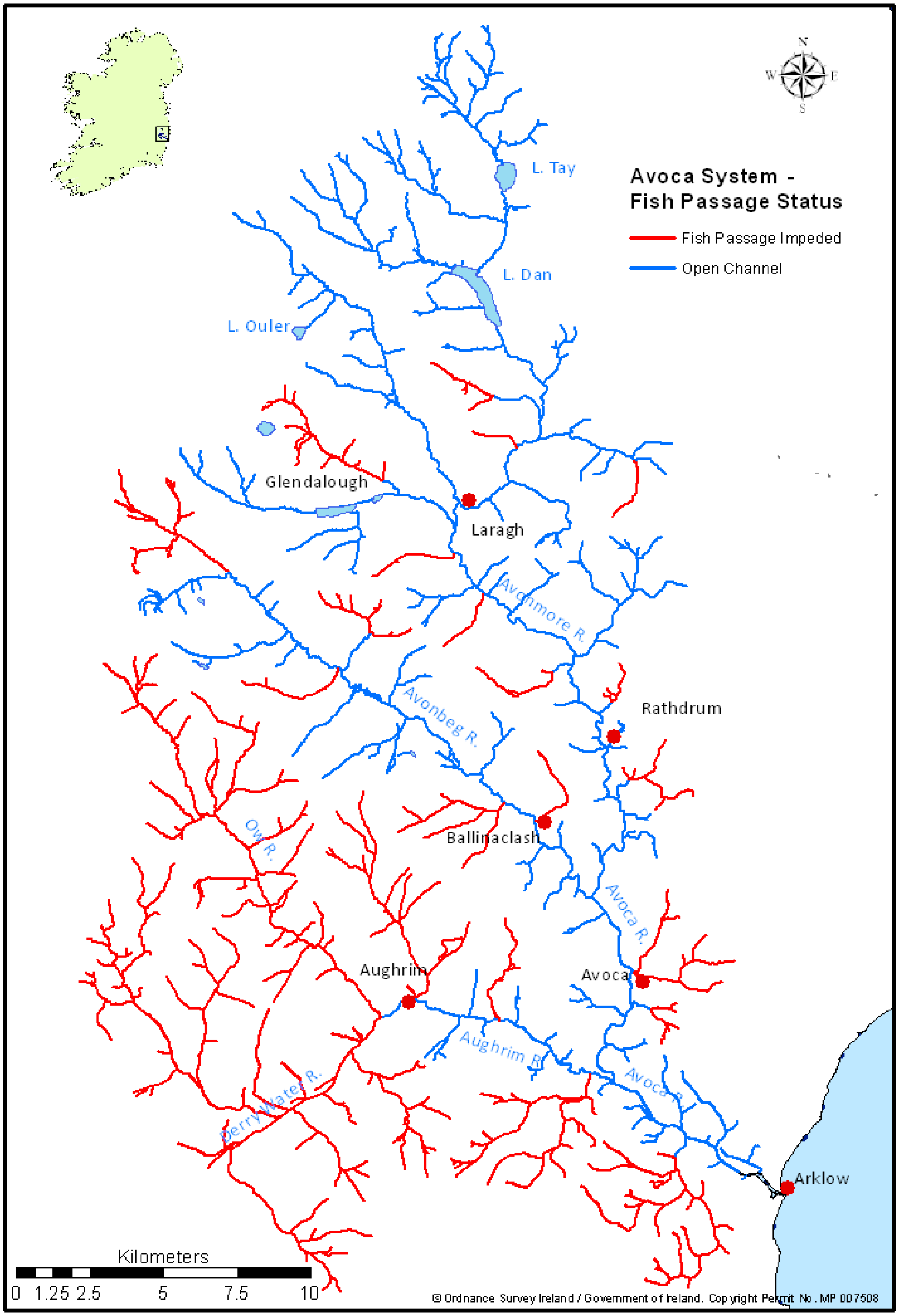


Figure 4. Map of the Avoca Catchment - unimpeded channel represented in blue and impeded (as a result of manmade structures) channel reaches represented in red.

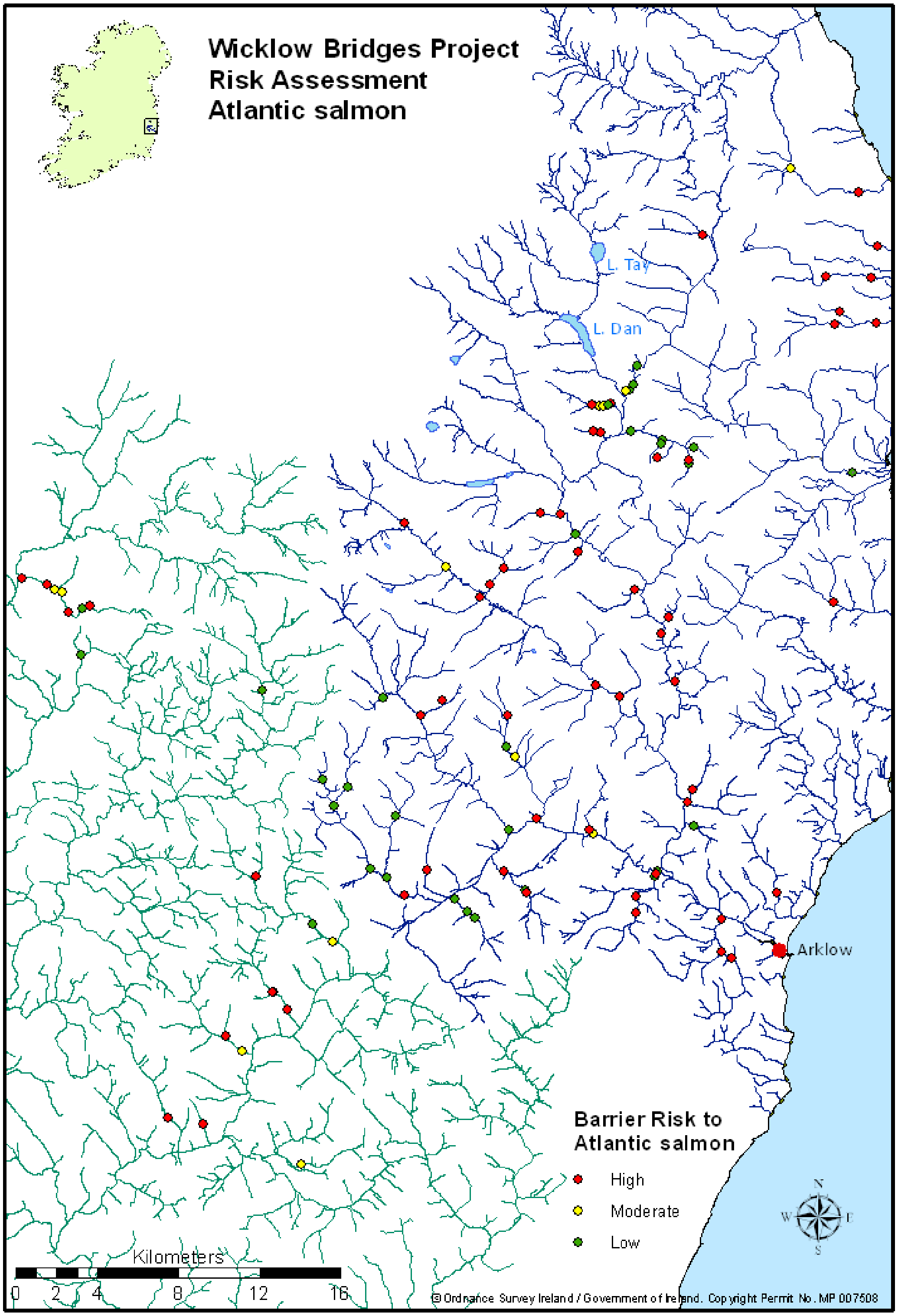


Figure 5. Thematic map of the all sites surveyed representing the risk to salmon migration associated with each structure

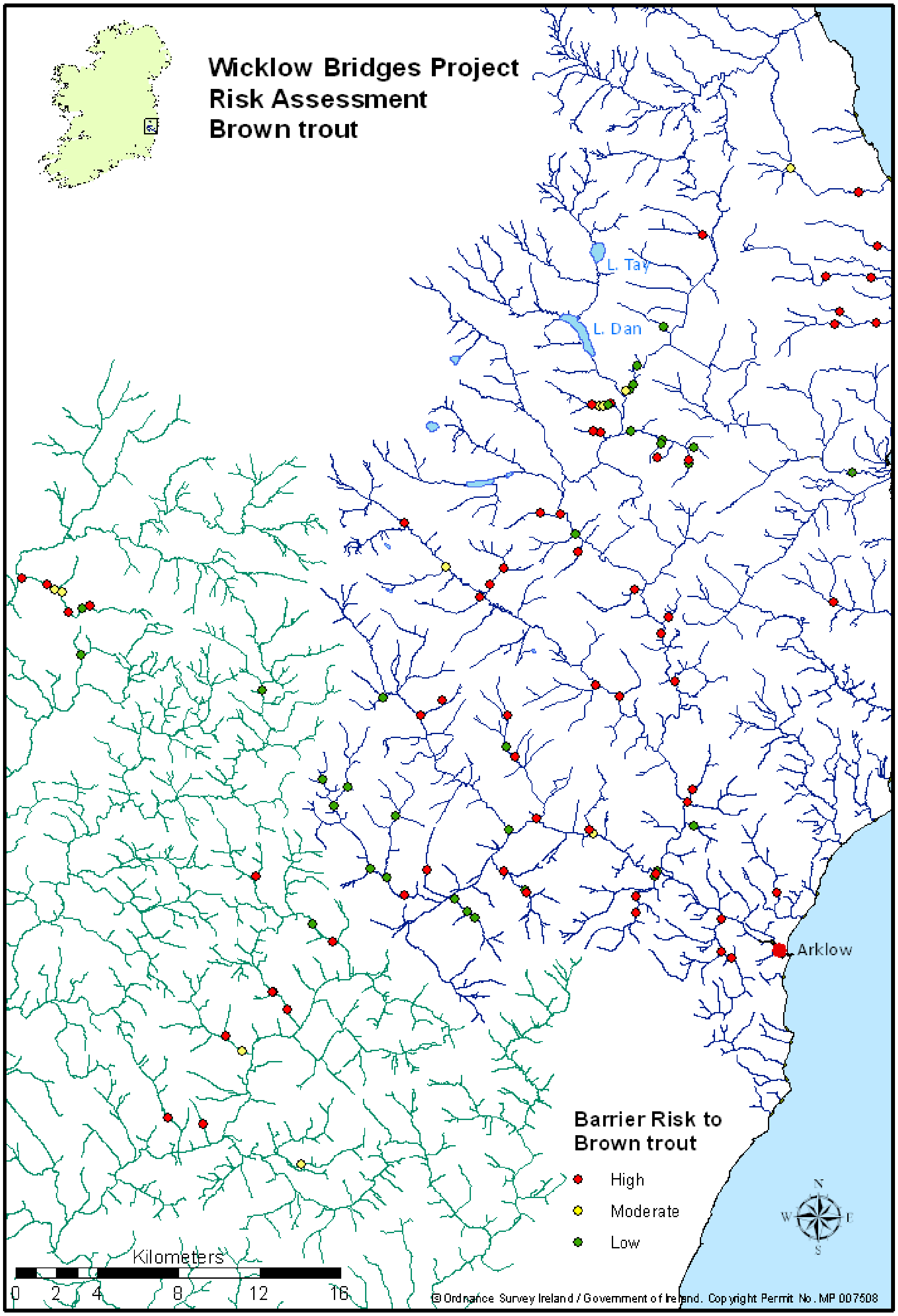


Figure 6. Thematic map of the all sites surveyed representing the risk to trout migration associated with each structure

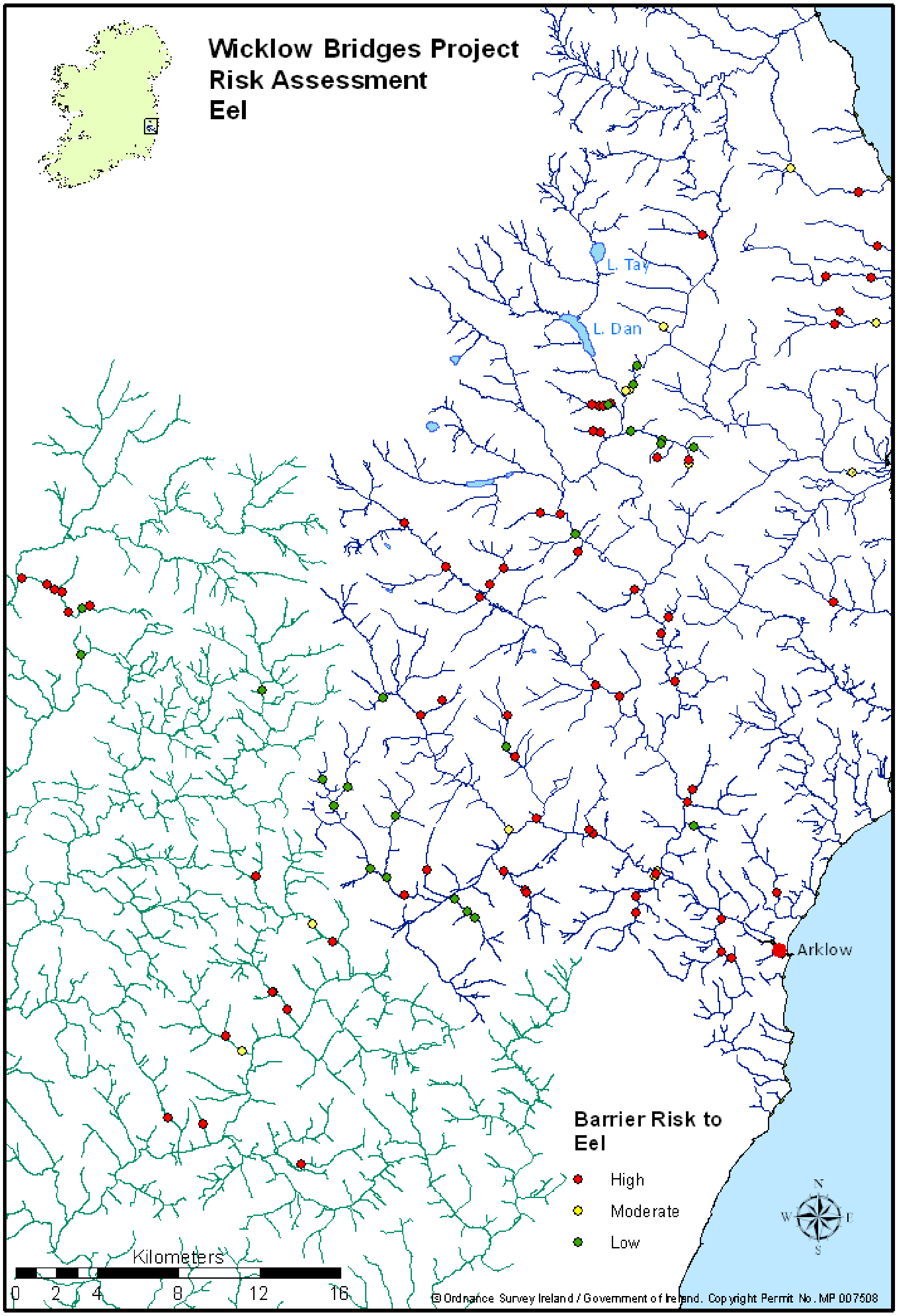


Figure 7. Thematic map of the all sites surveyed representing the risk to eel migration associated with each structure

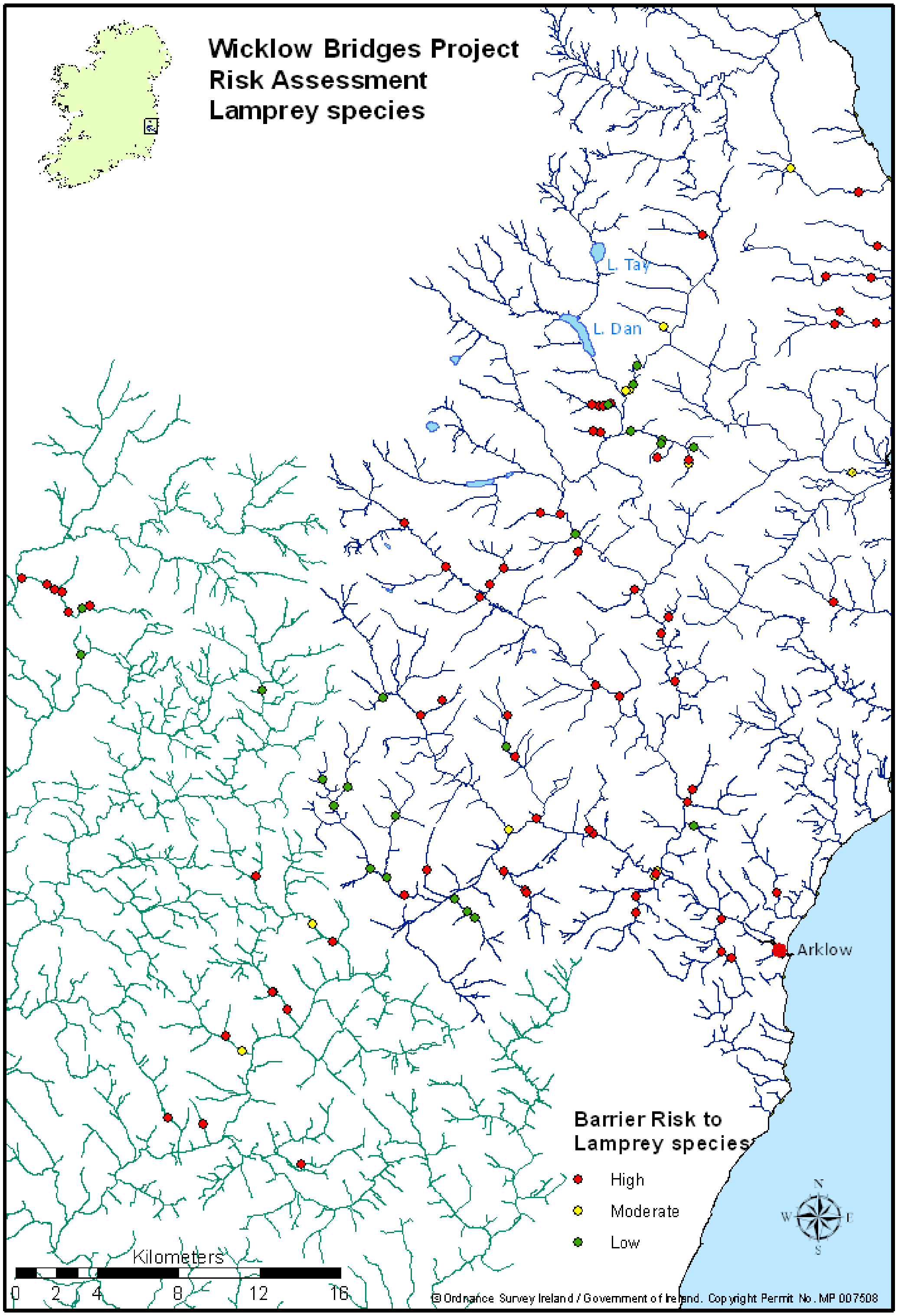


Figure 8. Thematic map of the all sites surveyed representing the risk to lamprey migration associated with each structure

4. Discussion

It is important to note that the assignment of risk category was based solely on field assessments made at each in-river structure. No account has been taken of the recorded presence or absence of specific fish species either up or downstream of those structures. The various types of problematic structure recorded are now discussed.

4.1 Scour protection aprons
The majority of the fish passage problems recorded related to the presence of stone or concrete structural bridge aprons. Fish attempting to migrate upstream at these locations are likely to jump onto a concrete or masonry surface which is covered with very shallow, fast flowing and unbroken water. Very few fish will succeed in negotiating such an obstacle. Most of the scour protection aprons encountered were composed of original masonry block work (probably installed during the original construction of the bridge). In many cases these older masonry aprons had been reinforced with concrete during more recent maintenance.

Fish passage at aprons may be impeded in a number of different ways, more usually resulting from a combination of the following site specific factors:

4.1.1 Flow velocity: Many scour protection aprons had a moderate slope and significant fall over their length (Table 3), resulting in high flow velocities. Salmonids are strong swimmers; however excessive flow velocities encountered were likely to exceed the swimming capacity of most fish species.

4.1.2 Laminar flow: Salmonids are capable of short bursts of rapid swimming movements after which they need to rest. In a natural river system the presence of boulders, and pools (natural hydromorphological features) provide refuge areas where fish can rest before expending another short burst of energy to migrate further upstream. The presence of laminar (smooth and unbroken) flows over many scour protection aprons indicates an absence of refuge potential for fish. Lamprey and eels are very "weak" swimmers and are even less likely to ascend scour protection aprons unless there are significant breaks in flow.

4.1.3 Perching of the structure: Perching is a term applied to an apron which is set above the stream bed immediately downstream, resulting in a fall. This can occur when the structure is installed too high, resulting in erosion of the downstream channel. On high energy systems such as the Avoca River, the potential for erosion downstream of such structures is increased.

The following series of photographs illustrates how these factors impact on fish movement in County Wicklow.

Figure 9. Ballinglen Bridge: This photo demonstrates the fish passage issues associated with laminar flow, flow velocity and the perching associated with this scour protection apron.

Figure 10. Threemilewater N11: photo demonstrates the combination of high velocities on a moderately sloped apron, laminar flow and perching, creating an impassable barrier to fish. This site would benefit from a mammal pass on this very busy/fast stretch of road

Figure 11. Photo showing a perched concrete scour protection apron on a tributary of the Avonmore River. The watercourse at this location represents excellent salmon nursery habitat. The main Annamoe to Laragh road is located immediately downstream of this site and the Armco Style culvert used for that crossing also represents an impassable barrier to fish passage.

Figure 12. Old masonry bridge structure near Avoca: composed of three masonry 'box' culverts with a long and moderately sloped concrete scour protection apron downstream. This photo shows the high velocities and laminar flow associated with this structure.

Figure 13. Photo of Ballyhad Bridge apron (Avonmore system: showing the perching, laminar flow and high velocities associated with this structure). Excellent salmon nursery habitat upstream. Site would also benefit from a mammal pass on this very busy/fast stretch of road.

Figure 14. Leabeg Stream at Leabeg Bridge: please note flow velocity and laminar flow associated with this moderately sloped concrete scour protection apron.

4.2 Solutions to fish passage issues associated with scour protection aprons

4.2.1 New structures

Where bridge aprons are required (for example to prevent scour damage), it is important that these structures should be formed well below the existing river bed level so as to remain backwatered (submerged). This configuration should provide a 'fishway' over their full length.

4.2.2 Existing structures

Anon (2000) describe options for improving accessibility to and passage through river crossing structures. Relatively low cost measures can be effective in many cases. Complete rebuild, using sound design principles to ensure that the new installation provides good fish passage conditions may be the only viable option for extreme problems.

There are two approaches to tackling excessive water velocity and sheer (laminar) flow. Both can also improve fish passage when water is too shallow.

(1) reduce water velocity by increasing the depth through the installation of one or more additional structures such as baffles

(2) introduce some roughness to the bed of the structure causing lowering of current speed and thus leading to some increase in water depth.

An effective approach to deepening the water and slowing the flow is to raise the tailwater level by installing a weir downstream of the scour apron. This will result in backing up the water level over the length of the apron. This approach can also ameliorate any perching problems such as found at Mullyclagh Bridge (on the upper reaches of the Carrigower in the Slaney catchment). Figures 15 and 16 illustrate the retrofitting of a number of low level weirs downstream, which was implemented as part of a road and bridge realignment project undertaken by the NRA and Wicklow County Council in late 2012. Figure 17 demonstrates the generic design of a 'low level weir' solution (Anon, 2000). The weirs downstream of Mullyclagh Bridge (shown in Fig. 16) were constructed using rock. The use of rock is more aesthetically pleasing and more closely mimics natural conditions, but a variety of other materials could be used such as concrete, wood and metal.

Figure 15. Mullyclagh Bridge: site in headwaters of the Slaney catchment before the installation of a series of low level weirs downstream of the perched scour protection apron. Electro-fishing of this site found excellent populations of trout, and salmon parr, downstream of this apron.

Figure 16. Mullyclagh Bridge after road/bridge widening and incorporation of low level weirs.

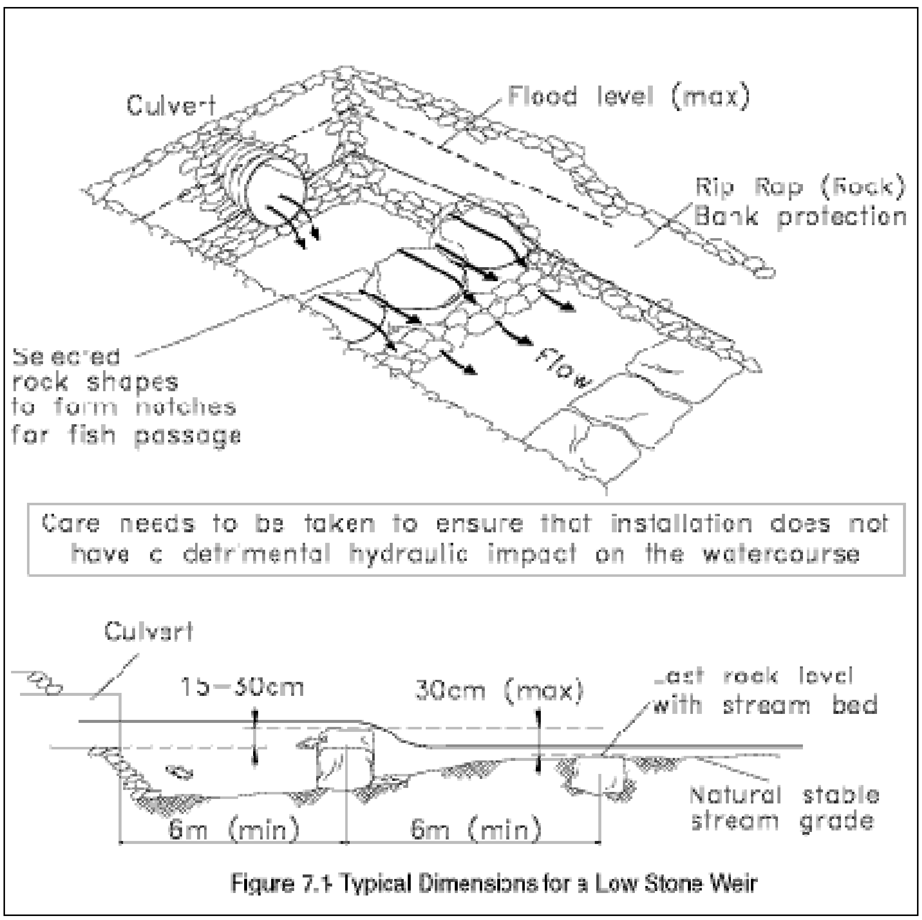


Figure 17. Detail for construction of a low level weir to alleviate flow and perching problems at a culvert outlet or scour protection apron (extracted from Anon, 2000)

4.3 Culvert structures

The designation of 'high risk' for all fish species was attributable to the presence of culvert structures at a large number of sites. Again fish passage was mainly impaired by excessive flow velocity, laminar nature of flow and the excessive perching of the structure. Anon 2000 states "Conditions at culvert outlets are frequently not conducive to successful jumps by salmonids. The stream below the fall may be shallow and the water turbulent, representing poor conditions for "take off" for a leap". Many of the problematic culverts encountered were again protected from scour with apron structures (which further compounded passage problems).

Many different forms of culvert were recorded (round, oval, square and rectangular). Box culverts (square and rectangular forms) were usually constructed using concrete. A number of older masonry built box culverts were also recorded.

Round concrete pipe culverts were regularly encountered on small watercourse crossings, while larger round and elliptical shaped corrugated steel culverts were mostly recorded at road and motorway crossings. A significant proportion of the watercourse crossings on private farm roadways were constructed using concrete pipes which were often undersized or perched, and in many cases both.

The following series of photographs illustrates how culverts impact on fish movement in County Wicklow.

Figure 18. Perched pipe culvert at Greens Bridge, headwaters of the Ballycreen/Macreddin Brook. Significant fall/jump downstream of pipe. Bank erosion noted downstream also.

Figure 19. Large perched concrete pipe culvert crossing of Avoca trib. on private road near Avoca. Sea trout noted in pool downstream of culvert. Fish passage difficulties at this site could have been avoided had this culvert been lain below bed level and backwatered.

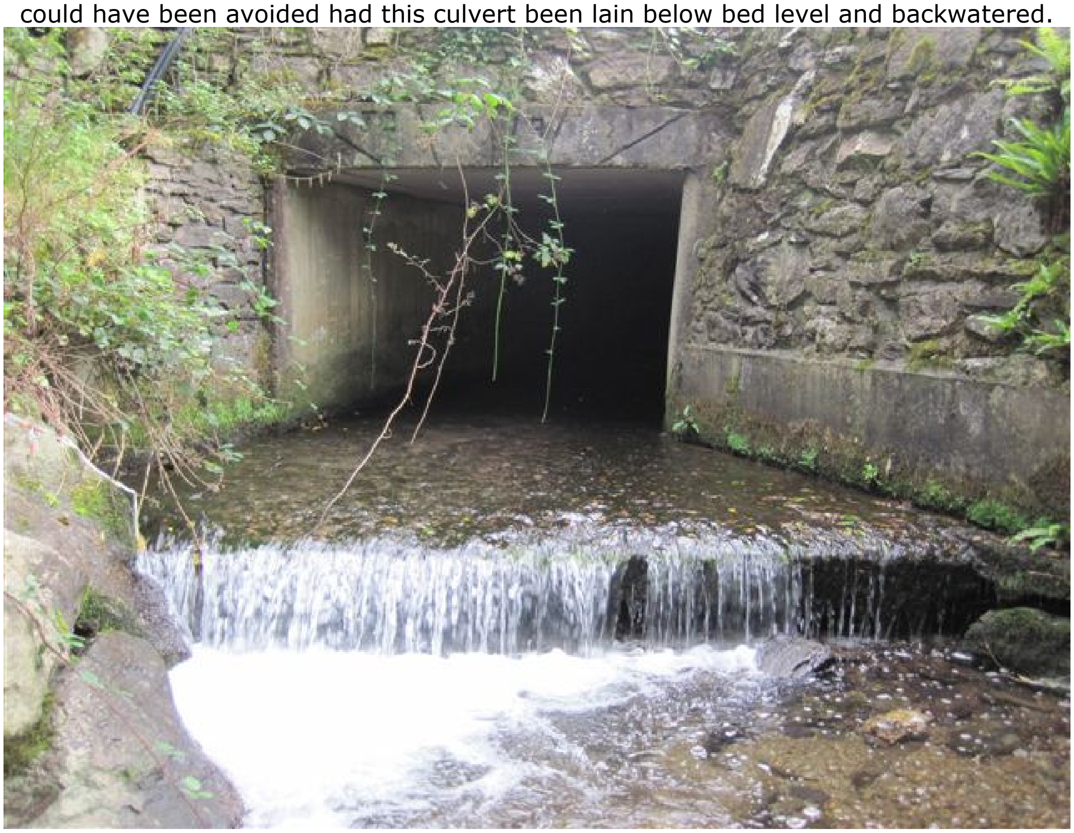


Figure 20. Box culvert with perched concrete scour protection apron. Private roadway on a Goldmine River trib. Structure represents significant impediment to fish passage.

Figure 21. Ford on Avonbeg Main Channel at Glenmalure. Structure is composed of a series of undersized concrete pipes lain parallel to each other and encased in concrete. The downstream movement of river bed material has blocked these pipes and the structure now acts as a dam.

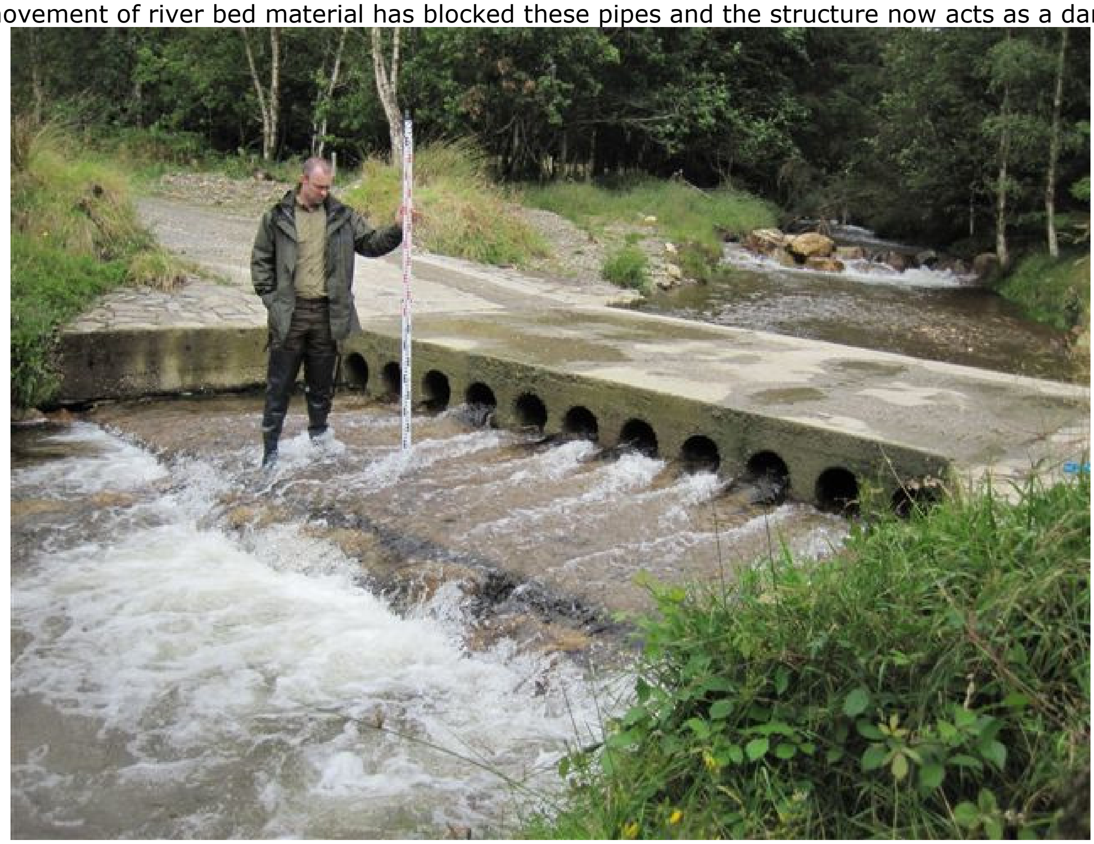


Figure 22. Ford structure on Avonbeg tributary, utilising undersized pipes encased in concrete, with scour apron downstream. Many of the culvert pipes were fully or partially blocked. Structure represents a significant impediment to the free passage of fish.

Figure 23. Perched pipe culvert crossing with scour protection apron over Mucklagh Brook, Ow river tributary. Structure represents barrier to the free passage of fish.

Figure 24. Ford Structure on Avonbeg trib. utilising undersized pipes encased in concrete, with scour apron. Majority of the culvert pipes fully or partially blocked. Structure represents a barrier to the fish passage, with excellent salmon spawning/nursery habitat u/s and d/s. Pipe size too small to facilitate most fish passage.

4.4 Solutions to fish passage issues associated with culverts

Where culverts are proposed, again it is important that these structures should be oversized and placed so as to remain backwatered throughout their entire length, thereby providing a fishway. Where legacy problems exist at culvert sites they can be addressed through the 'low-level weir' approach already discussed in Section 4.2.2.

Figure 25 shows Furnace Bridge (crossing a tributary of the Avonmore River), where an old masonry structure was replaced with a corrugated steel (Armco style) culvert. This structure was laid well below the upstream invert of the stream and therefore is backwatered over its entire length. The Furnace Bridge site has developed a natural gravel river bed throughout, which provides habitat for fish and facilitates their free passage at all times. A box culvert on the Griffeen River (Liffey trib.) in County Dublin is shown in Fig. 26. This culvert was also laid well below (>500mm) the upstream invert of the stream and ensures fish habitat throughout the structure and the free passage of all fish at all times. The Griffeen box culvert also includes a mammal pass (something that would be difficult to incorporate/retrofit into the Furnace Bridge culvert because of its shape).

Figure 25. Furnace Bridge, Armco style culvert, which replaced an old masonry bridge, structure constructed well below bed level, backwatered throughout, natural bed material deposition within structure, fish habitat over length of structure maintained. Free passage of fish guaranteed. This site would also benefit from a mammal pass on this very busy/fast stretch of road.

Figure 26. Griffeen River, Liffey trib. Co. Dublin. Backwatered box culvert. Culvert bed 500mm below river bed level. Natural bed material deposition within structure, fish habitat and passage over length of structure maintained. Structure includes a mammal pass, the incorporation of which would have been very difficult within a round/elliptical culvert

4.5 Weirs and Dams

We included a small number of weirs and dams to highlight their importance to the fish passage question. A number of bridges with fish passage issues were located upstream of dams and weirs which themselves represented impassable barriers to fish passage. It is vital that any future initiatives focusing on issues recorded during this survey would be cognisant of fish passage problems at other (weir or dam) impassable structures downstream.

The Goldmine Water abstraction dam, an old fish pond weir on the Ballyduff River, an old weir on the Stranakelly Brook, a weir on the Macreddin/Ballycreen Brook in Aughrim and a water abstraction weir on the Derry River upstream of Tinahely were assessed. In each case the structures represented significant impediments to fish passage. It is unlikely (with the exception of the Tinahely water abstraction weir) that there is any migration of fish upstream of these structures.

Figure 27. Dam across the Macreddin/Ballycreen Brook in Aughrim. This structure represents an impassable barrier to fish passage. Excellent salmon spawning/nursery habitat upstream of this site. Catchment wide electrofising survey of the Avoca system in 2002 highlighted the absence of juvenile salmon on the Macreddin/Ballycreen Brook upstream of this structure.

Figure 28. Dam across the Ballyduff Stream a close to Arklow. Original purpose of this dam believed to be the creation of a fish pond. Structure represents an impassable barrier to all fish passage, with excellent salmon spawning/nursery habitat upstream.

Figure 29. Structure at Preban Bridge (Derry Water system) near Ballinglen purpose of which we were informed was to provide for a gravity feed water supply to nearby farm

5. Conclusions

5.1 Context

- Where barriers impede or block access of migratory fish to large portions of catchments a direct reduction in the production potential of these systems results. Biodiversity and associated economic value suffer as a result.

- European Eel stocks are currently outside safe biological limits - obstacles to migration in river systems were identified as one of several factors causing this dramatic decline.

- Species such as the Atlantic salmon, River Lamprey and Sea Lamprey are listed under Annex IIa and Va of the Habitats Directive. The Habitats Directive defines certain types of natural habitat and certain species which are seriously threatened as having priority in order to favour the early implementation of measures to protect them.

- The Standing Scientific Committee on Salmon's report The Status of Irish Salmon Stocks in 2011 with precautionary Catch Advice for 2012, includes information on Irish salmon stocks, the current status of these stocks relative to the objective of meeting biologically referenced "Conservation Limits" and the catch advice which will allow for a sustainable harvest of salmon in 2012 and into the future. According to this report a number of Wicklow Rivers are failing to achieve their Conservation limits, these include the Avoca, Slaney, Vartry, Liffey and Dargle.

- "In Ireland, the Water Framework Directive Freshwater Morphology Programme of Measures and Standards identified barriers to fish migration as one of the principal issues placing channels "at risk" in terms of failing to achieve good or high status as required under WFD" (Gargan et al, 2011).

5.2 Wicklow Bridges Project Findings

- Assessments undertaken as part of the Wicklow Bridges Project confirmed numerous impediments to fish passage on watercourses throughout County Wicklow. The scale of the problem in the Avoca catchment alone is highlighted in Figure 4. This map demonstrates that approximately 50% of the entire catchment is potentially impaired (fish migration partially or fully blocked).

- The assessments undertaken through the Wicklow Bridges project represent an important step in the process of establishing a comprehensive baseline of barriers to fish passage in the Eastern and South Eastern River Basin Districts.

- We believe that the works recently undertaken at Mullyclagh Bridge, (Figures 15-17) demonstrate a relatively simple solution to fish passage issues at most existing scour protection aprons. We understand that the cost of the works undertaken at the Mullyclagh Bridge site were in the region of €5000. We would be hopeful that many of the fish passage issues highlighted at smaller bridge and culvert sites could be rectified with similar solutions when routine bridge repairs/maintenance operations are being carried out by relevant authorities (Wicklow County Council or the National Roads Authority).

- The size and scale of the works required for the provision of solutions to fish passage issues at larger bridge/weir/dam sites means that the associated costs are likely to be far higher and unlikely to be included within the budget of bridge maintenance/repair works. The costs associated with larger projects mean that these works will often require specific funding which in many cases may be prohibitive. In such cases there may be other funding options available such as:

  <u>The Salmon Conservation Fund</u>
  Salmon Conservation Fund is generated from the sale of salmon angling and commercial fishing licences. The revenue generated from the Salmon Conservation Fund is reinvested to promote the recovery of salmon stocks and habitats taking into account project feasibility, funding availability and value for money

considerations. The fund is managed by Inland Fisheries Ireland and projects are assessed based on the river's conservation limit, water quality and the maximum potential project benefits to the river with funding prioritised for those rivers in most need of rehabilitation.

LEADER Programme
Another potential funding option is the LEADER Programme, whereby the County Wicklow Partnership could be a potential source of funding under the LEADER programme for community driven initiatives to facilitate the free passage of fish at sites where their migration is impeded and to enhance the biodiversity value of bridges and any related channels upstream.

NEXT STEPS...

Develop a cost / benefit approach involving all relevant agencies and stakeholders with a view to prioritising sites where the greatest environmental benefit may accrue from further work. It is hoped that any subsequent work would contribute directly to the development, protection and conservation of all fish and more generally Co. Wicklow's overall bio-diversity.

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