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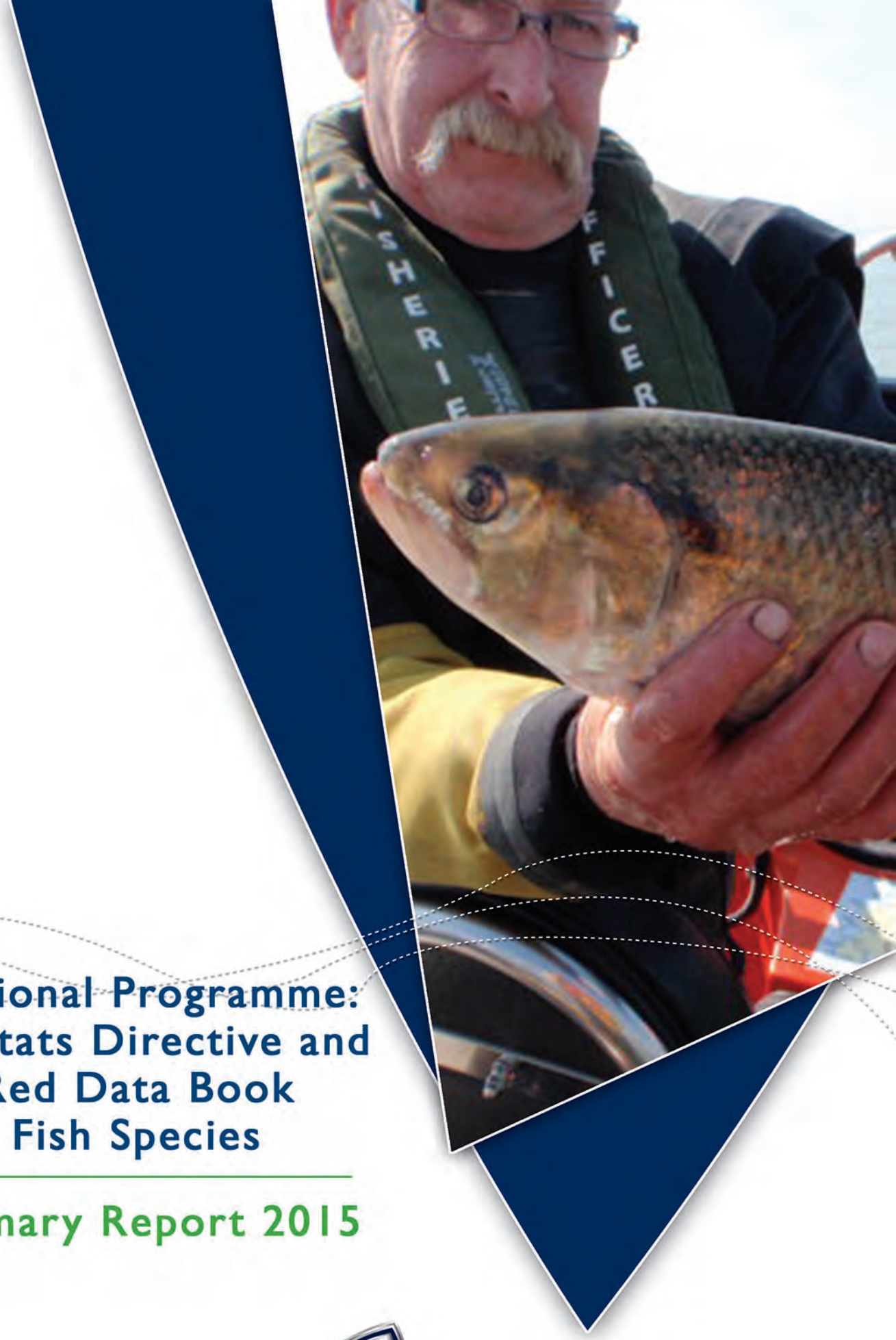

National Programme: Habitats Directive and Red Data Book Fish Species

Summary Report 2015

IASCACH INTÍRE ÉIREANN
INLAND FISHERIES IRELAND

National Programme: Habitats Directive and Red Data Book Fish species

Summary Report 2015

IFI Report Number: IFI/2016/1-4344

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Habitats Directive and Red Data Book Fish species 2015: Executive Report

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1. Introduction

The Habitats Directive (Council Directive 92/43/EEC) is intended to protect biodiversity in Europe and under this legislation EU states are required to maintain or restore threatened habitats (as listed in Annex I) and species (as listed in Annexes II, IV and V) at a favourable conservation status. The Directive was transposed into Irish law in 1997 by the European Communities (Natural Habitats) Regulations, SI 94/1997 and these were subsequently revised and consolidated in the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.

The conservation of Annex I habitats and Annex II species involved the establishment of protected sites known as Special Areas of Conservation (SACs). These form part of a network of Natura 2000 sites which include Special Protection Areas (SPAs) as established under the EU Birds Directive (2009/147/EC). Seven species of fish are listed in Annex II and/or Annex V of the Habitats Directive (Table 1.1). These include the 3 species of lamprey found in Ireland (*Petromyzon* sp. and *Lampetra* spp.), 2 species of shad (*Alosa* spp.), Atlantic salmon (*Salmo salar*) and Pollan (*Coregonus autumnalis*). The protection of Annex V species involves EU states ensuring their exploitation and taking in the wild is compatible with maintaining them in a favourable conservation status.

Under the Irish implementing legislation, IFI undertakes monitoring of the above-named fish species on behalf of the Minister for Communications, Climate Action and Environment. The conservation of Atlantic Salmon is is undertaken on a catchment basis with no exploitation, by commercial or leisure means, in mixed fisheries or inshore waters. The national Standing Scientific Committee determines the annual status of catchments for salmon exploitation. The conservation status of the remaining 6 species is assessed by the Habitats Directive team within IFI's Research and Development Division. The team also monitors 2 other fish species that are of conservation interest and are listed in the current Red Data Book (King *et al*. 2011), namely, Arctic char (*Salvelinus alpinus*) and smelt (*Osmerus eperlanus*). Both of these species have a restricted distribution in Ireland and IFI has implemented long-term monitoring programmes to review their status. ºC

Table 1.1. Fish species monitored by IFI under the Habitats Directive and Red Data Book.

	Habitats Directive	Red Data Book
Sea Lamprey (*Petromyzon marinus)*	Annex II	Near threatened
River Lamprey (*Lampetra fluviatilis*)	Annex II, V	Least concern
Brook Lamprey (*Lampetra planeri)*	Annex II	Least concern
Twaite Shad (*Alosa alosa fallax*)	Annex II, V	Vulnerable
Killarney Shad (*Alosa fallax killarnensis)*	Annex II, V	Vulnerable
Pollan (*Coregonus autumnalis*)	Annex V	Vulnerable
Atlantic Salmon (*Salmo salar*)*	Annex II, V	Vulnerable
Arctic Char (*Salvelinus alpinus*)	-	Vulnerable
Smelt (*Osmerus eperlanus*)	-	Least concern

*Atlantic salmon is monitored under IFIs National Salmon Monitoring Programme

Fourteen SACs have been designated for the lamprey and shad species listed in Annex II (Figure 1.1). Conservation status is assessed by monitoring both within and outside of these SACs and surveys are carried out on a number of catchments throughout the country on a cyclical basis. Ireland is required

to report every 6 years on the findings of this monitoring according to Article 17 of the Directive. The current reporting cycle is in its fourth year and the next assessment of the conservation status of the relevant fish species will be in 2018.

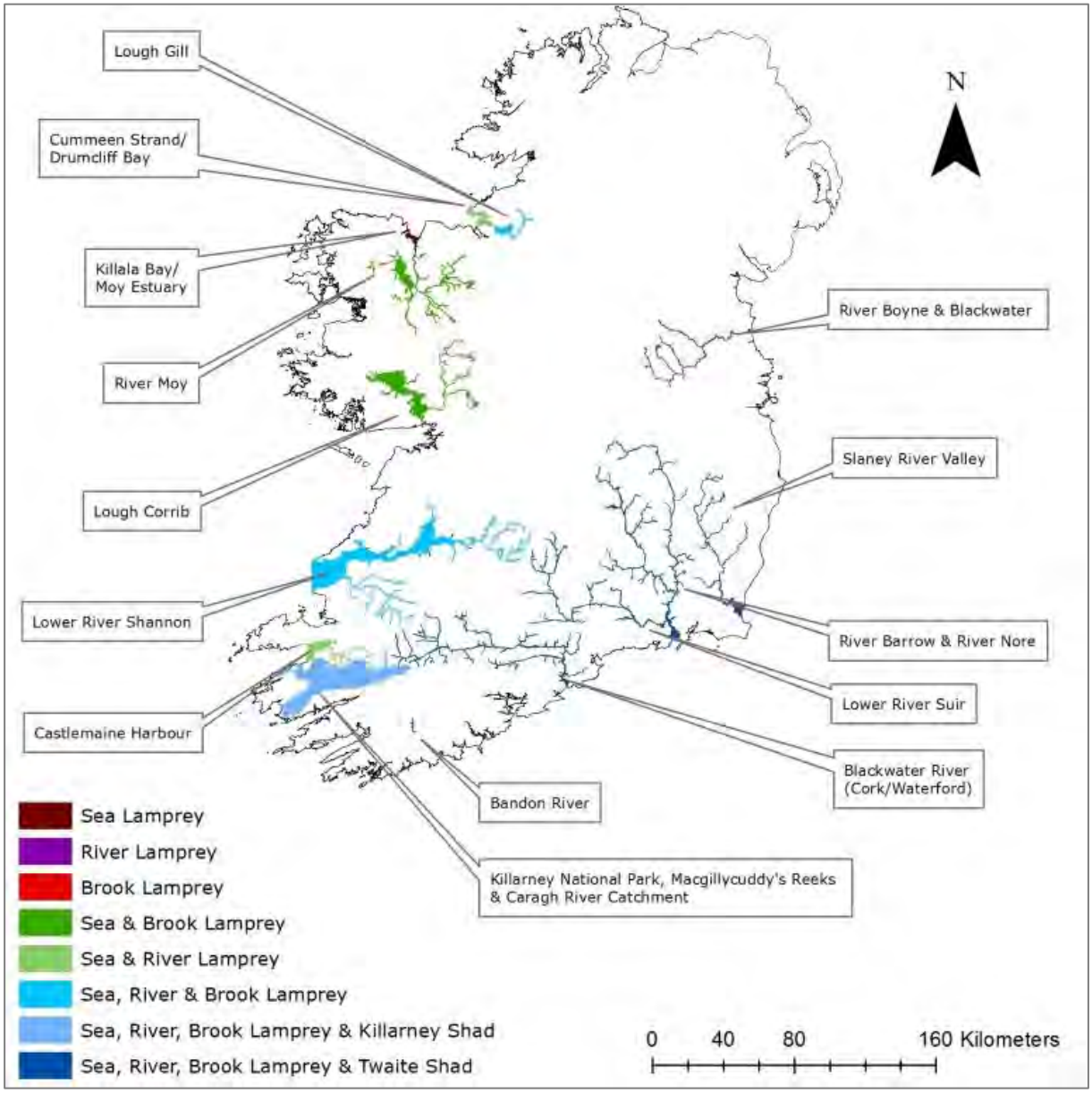


Figure 1.1. Map showing the SACs designated for species of lamprey and shad as listed in Annex II of the Habitats Directive.

2015 was the third year of the current six-year reporting cycle to the EU (2013 – 2018), under Article 17 of the Habitats Directive. In addition to a substantial survey programme, the team produced its annual report for 2014, attended and presented study outcomes at relevant conferences and workshops in Canada, Netherlands and France and had two peer-review journal articles published during 2015.

1.1 Lamprey investigations in 2015

As per the sampling strategy for 2013-18, two further SAC catchments were selected for catchment-wide juvenile lamprey surveys. The Slaney and Boyne were targeted and completed. In both cases,

the whole catchment was surveyed as opposed to confining the sampling within the SAC only. The Slaney had been previously surveyed for larval lamprey by IFI in 2003 and the Boyne was surveyed by Ecofact Ltd. in 2005. Both of these studies had been commissioned by the National Parks and Wildlife Service.

The programme of sampling Index or Reference Channels was continued in 2015. The purpose of this network is to permit a more robust assessment of 'trends' in larval lamprey presence, population size and structure, as required under Article 17 (Monitoring and Assessment) of the Habitats Directive. The Habitats team plans to complete annual or biennial sampling on a series of the selected Index Channels in advance of completion of the next Article 17 report to the EU (June 2019).

1.2 Shad investigations in 2015

As in previous years Bongo netting was employed in 2015 to sample for post-larval and early free-swimming stages of shads in the estuaries of the designated SAC rivers of the south east.
The IFI's Marine Sport Fish team undertook sampling for bass via trawling in Waterford Harbour and adjoining water of the lower Suir and Barrow estuaries in September 2015, supported by the Habitats team. A sample of young-of year shad was obtained as by-product of the bass trawling.
Samples and individual specimens of marine-caught shad were provided by colleagues from the Marine Institute and Bord Iascaigh Mhara (BIM). Such material continues to contribute to a growing database on occurrence and location of shads at sea, in addition to biological information compiled from individual fish. The on-going support of the three organisations – Marine Institute, BIM and Sea Fisheries Protection Authority – to this study is very welcome and essential.

1.3 Pollan investigations in 2015

The success of pelagic nets as a sampling device for pelagic fish species – such as Killarney shad, char and pollan – was demonstrated in studies in 2014. Based on this, a discrete sampling programme was undertaken in L. Allen in 2015, using pelagic nets set overnight at different levels in the water column. Sampling was undertaken on a seasonal basis with surveys in summer (June), autumn (September) and winter (January 2016). While the latter was not done within the calendar year it formed part of the survey continuum and the set of three surveys is reported here.

1.4 Smelt investigations in 2015

The estuarine bongo netting for shad also served as a smelt recruitment assessment mechanism. The smelt samples provided an opportunity to collect more detail on length –weight relationships for the very young life stages of smelt. In addition, counting of gill rakers was undertaken for the young post-larval fish.

The IFI's Marine Sport Fish team undertook sampling for bass via trawling in Waterford Harbour and adjoining water of the lower Suir and Barrow estuaries in September 2015. Habitats team provided some support and substantial samples of smelt were obtained as by-product of the bass trawling.

1.5 Char lake surveys in 2015

Surveys were conducted for char on two lakes in Donegal and on two lakes in Kerry with staff of IFI's RBDs. The Habitats team is particularly grateful to the local fishery owners and angling clubs who facilitated the surveys.

The netting procedure is identical to that used by IFI's Water Framework Directive survey teams, enabling a sharing of data sets on char lakes. The Habitats team surveys lakes NOT on the WFD listing, to ensure maximum national coverage of waters.

1.6 Hydromorphology – barriers surveys in 2015

Barriers to fish passage are identified as being a major impactor on some of the anadromous species that form the remit of the Habitats team. The issue of barriers is also relevant in the Water Framework Directive (WFD), in the context of hydromorphology and continuity. Surveys of major barriers on the SAC channels, using the SNIFFER barrier passability technique commenced in 2014 and were continued in 2015. Assessments were undertaken in the main stem River Slaney and in the main stem and tributaries of the River Feale, a part of the Lower River Shannon SAC.
A catchment-wide study of barrier distribution in the Barrow system was also commenced in 2015 with a scheduled completion in 2016, working with colleagues from the South Eastern RBD and using the electronic barrier survey forms developed for IFI.

2. Lamprey Programme

2.1 Larval Lamprey investigations

2.1.1 Boyne Catchment Wide Survey

The Boyne catchment is one of the largest in the country, draining a significant portion (2700km^2) of the east midlands, in doing so spanning several counties, namely Meath, Louth, Westmeath, Kildare and Offaly. The importance of this catchment is emphasised by its almost complete designation as two SACs, the River Boyne and River Blackwater SAC (#2299) and the Boyne Coast and Estuary SAC (#1957). Relevant features of interest in the former SAC include river lamprey (*Lampetra fluviatilis*) and Atlantic salmon (*S. salar*). The catchment comprises several sub catchments, the most substantial being the Kells Blackwater, which in itself amounts to 25% of the overall drainage area. Other sub catchments include the Athboy/Tremblestown, Deel, Enfield/Longwood Blackwater, Kinnegad, Stoneyford, Yellow, Knightsbrook, Boycetown, Skane and Mattock rivers. The catchment chiefly consists of peatland and flat agricultural habitats with some hilly sections fringing the northern and northwestern extremities in Counties Cavan, Meath, Louth and Westmeath. Two major lakes, Ramor and Lene, are located within the catchment, as well as a number of large towns (Navan, Kells, Trim and Virginia). The town of Drogheda is located towards the end of the 113km main Boyne river channel at the upper tidal limits and the interface between both the aforementioned SACs.

Plate 2.1. The River Boyne at Newgrange, Co. Meath.

Discharges from these various towns, in conjunction with agricultural and peat extraction activities in rural environs, constitute significant sources of pressure upon the catchment through pollution, eutrophication and siltation. Widescale arterial drainage schemes and ongoing channel maintenance has also affected the form and function of most of the sub catchments and sections of the main river, with channelisation and steep-sided high banks in evidence throughout. Water quality is an issue on the Boyne Catchment and only 24% of assessed river channel achieved good or high ecological status

for the WFD monitoring period 2010 – 2012. Of the remaining channels, 58% were assessed as moderate and 19% had a poor status. The EPA stated that, within the Eastern River Basin District, a loss of high status channel and increase in poor status channel was notable in the Boyne for that period (EPA 2015). A number of low-head barriers to fish migration are present along lower sections of the main river channel, the most substantial of these located at Slane and downstream of Navan at Blackcastle. A number of potential barriers are also present on the Kells Blackwater.

A full catchment-wide ammocoete survey was undertaken in 2005 (O'Connor, 2006). *Lampetra* spp. ammocoetes were obtained at the majority of sites surveyed, with the exception of the upper reaches of some of the sub catchments, the Kells Blackwater and Yellow River for instance, and along a number of mid-section tributaries, namely the Boycetown and Skane rivers. It was concluded that lamprey populations were at a favourable conservation status, with the exception of the aforementioned tributaries. Presence of heavy vegetation in drained channels, as well as profusions of filamentous algae and calcification of river bed substrate, were noted during surveying in 2005.

Plate 2.2. The weir at Slane, Co. Meath

A complete resurvey was undertaken during August, September and October 2015. An amount of lamprey surveying had been undertaken at locations throughout the catchment prior to this. The Kells Blackwater was selected in 2013 as one of a number of reference channels countrywide where repeated ammocoete surveying would be undertaken (see Section 2.1.3). Electrofishing was performed during September 2014 at 5 main channel sites on the Kells Blackwater between Lough Ramor and Navan, as well as at a single location upriver of Lough Ramor at Murmod Bridge. All 6 sites were locations surveyed previously in 2005. From November 2014 to April 2015 efforts to trap live adult river lamprey were undertaken at 4 locations throughout the catchment. This was augmented in April 2015 by an expansive fyke-netting survey (see Section 2.2.5.1 for details). While no adult river lamprey were encountered during the trapping exercise, a dead individual was found beside the River Boyne at Slane in late March 2015 by IFI protection staff. In April 2015, brook lamprey were observed spawning in a tributary of the Kells Blackwater near Gibbstown, Co. Meath, whilst a single adult

Lampetra planeri was observed swimming upriver through an area of suitable spawning substrate on the Mattock River near Dowth, Co. Meath. A recently constructed sea lamprey redd was noted at Newgrange during floatover surveying along the main channel River Boyne downstream of Slane in July 2014, simultaneous with angler reports of sea lamprey carcasses 2km upstream at Rossnaree. It was hoped that ammocoetes of both *Petromyzon* and *Lampetra* spp. would be encountered during the 2015 resurvey.

A total of 109 sites throughout the Boyne catchment were preselected for survey. All 109 sites were visited (Figure 2.1). Surveying was not possible at 7 sites due to lack of access and/or no obvious suitable ammocoete habitat. Semi-quantitative electric fishing surveying was undertaken at all remaining 102 locations. *Lampretra* spp. ammocoetes (total n=583) were encountered at 73 (72%) of the 102 sites (Table 2.1). A broad range of age classes (12-153mm) were represented (Figure 2.2). Densities of river/brook ammocoetes at positive sites ranged from 1-42 individuals per m^2 (Figure 2.3). Sea lamprey ammocoetes were not encountered, despite surveying downstream of historical spawning locations.

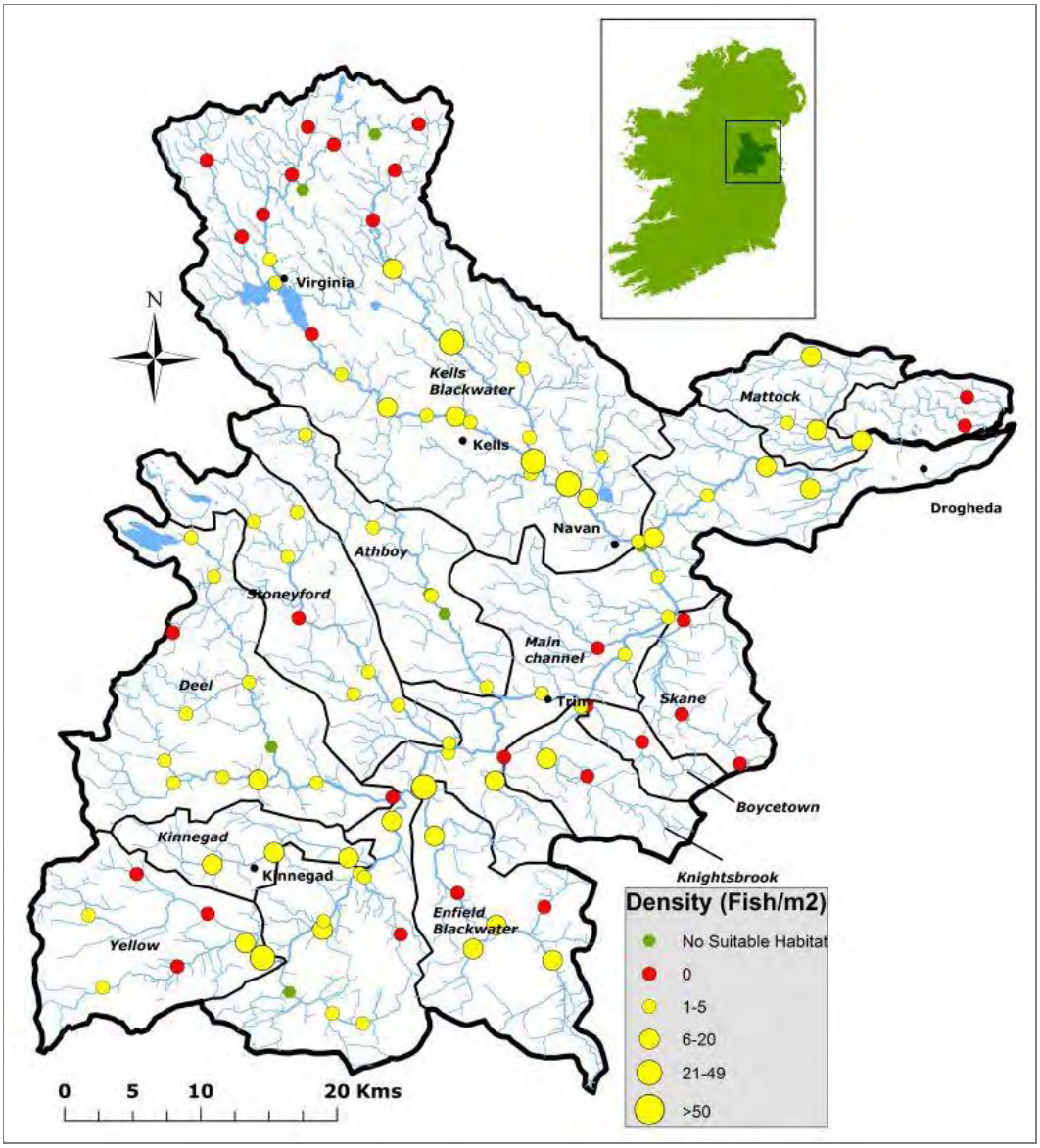


Figure 2.1. Map outlining sampling locations across the Boyne catchment for ammocoetes, August-October 2015.

Table 2.1. Comparison of distribution, density, population structure of *Lampetra* spp. ammocoetes across the Boyne catchment, August - October 2015.

	No. Sites	No Suitable Habitat	No. positive Sites	Max. Density (Fish/m^2)	Min. Density (Fish/m^2)	Mean Density (Fish/m^2)	Max. Length (mm)	Min. Length (mm)
Athboy / Tremblestown (km^2)	6	2	4	4	3	3.25 (n=15)	132	37
Boycetown (km^2)	2	0	0	-	-	-	-	-
Deel (km^2)	12	1	9	7	2	3.7 (n=35)	135	45
Enfield Blackwater (km^2)	7	0	5	26	9	13.6 (n=68)	132	16
Kells Blackwater (km^2)	29	2	17	42	1	10.1 (n=182)	215	22
Kinnegad (km^2)	3	0	3	18	11	14 (n=50)	121	12
Knightsbrook (km^2)	3	0	2	14	1	7.5 (n=15)	127	38
Main Channel Boyne (km^2)	23	2	18	15	1	7.1 (n=128)	153	17
Mattock (km^2)	4	0	4	15	4	9.3 (n=37)	148	51
North Drogheda (km^2)	2	0	0	-	-	-	-	-
Skane (km^2)	3	0	0	-	-	-	-	-
Stoneyford (km^2)	8	0	7	5	1	2.7 (n=17)	137	40
Yellow (km^2)	7	0	4	21	2	9 (n=36)	143	45

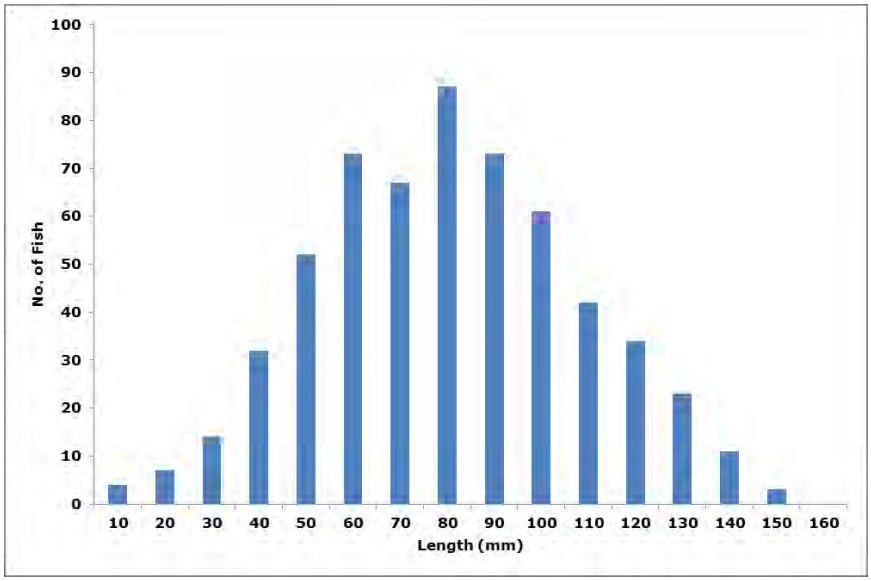


Figure 2.2 Length frequency distribution of *Lampetra* spp. ammocoetes captured at locations across the Boyne catchment in 2015 (n=583).

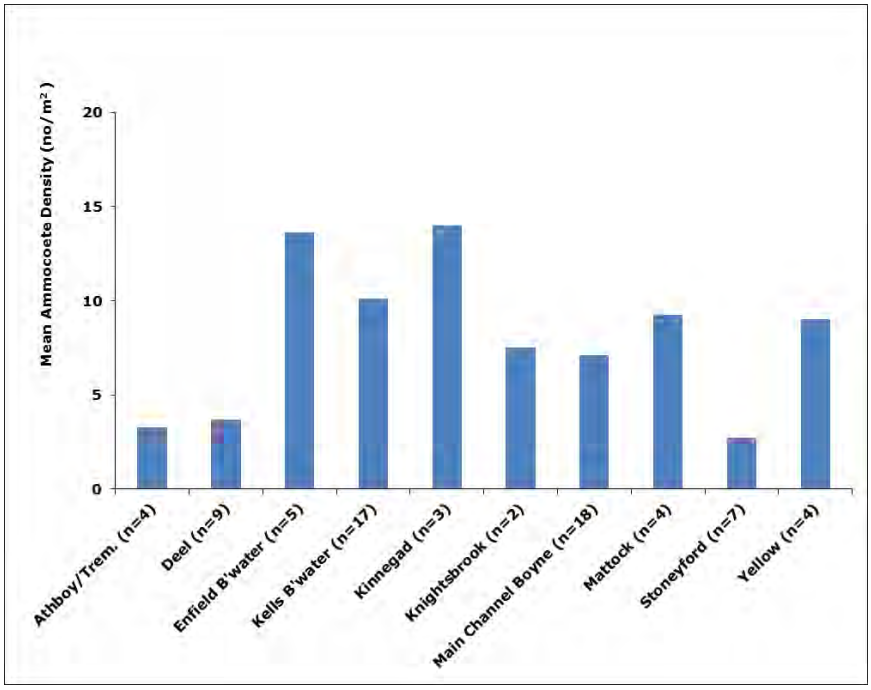


Figure 2.3 Comparative densities of *Lampetra* spp. ammocoetes recorded on tributary and main stem channels of the Boyne catchment during 2015.

Sub catchments upstream of Trim

Six tributary systems merge with the main stem Boyne at various locations upstream of Trim, namely the Enfield/Longwood Blackwater, Yellow, Kinnegad, Deel, Stoneyford and Athboy/Tremblestown rivers (Figures 2.5.1-6). *Lampetra* spp. ammocoetes (n=221) were encountered across all six sub catchments (Table 2.1), with maximum densities recorded ranging from 4 individuals per m^2 (Athboy/Tremblestown) to 26 per m^2 (Enfield/Longwood Blackwater). A relatively high proportion of sites (3 out of 7; 43%) across the Yellow River were negative (Figure 2.5.2), two of which were located along the Castlejordan River. The remaining 4 positive sites were well dispersed spatially across this sub catchment. Similarly with the Enfield/Longwood Blackwater, where two negative sites (2 out of 7; 29%) were located downstream of positive sites (Figure 2.5.1). Channelisation with

resulting steep banks and profuse instream emergent vegetation precluded a small number of sites from survey (Deel, n=1 and Athboy/Tremblestown, n=2) with no suitable alternative locations available in the vicinity to serve as replacement sites. The overall age structure of *Lampetra* spp. ammocoetes across these six sub catchments suggests the presence of several cohorts (Figure 2.4, 12-143mm).

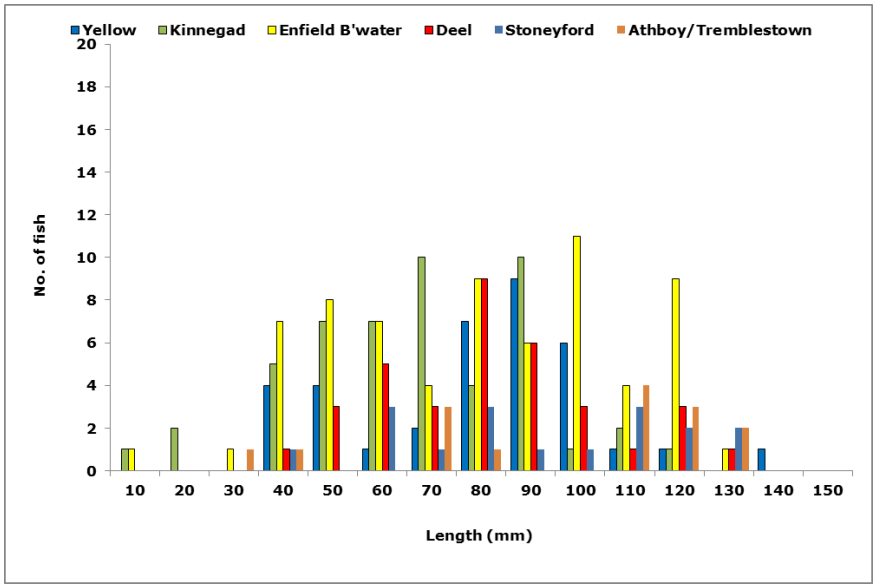
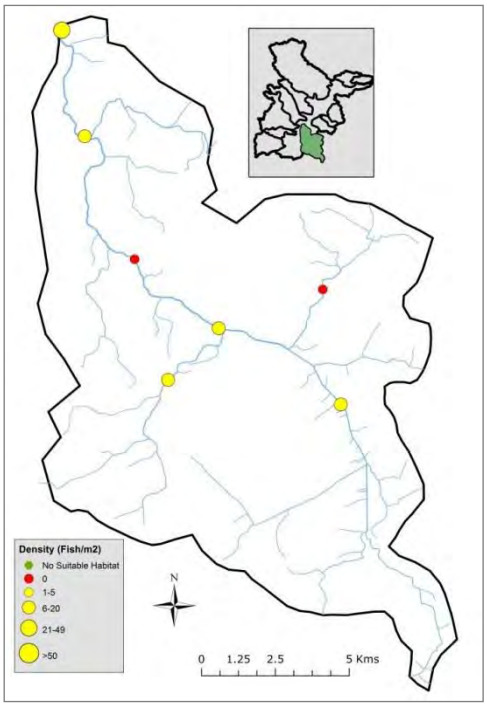
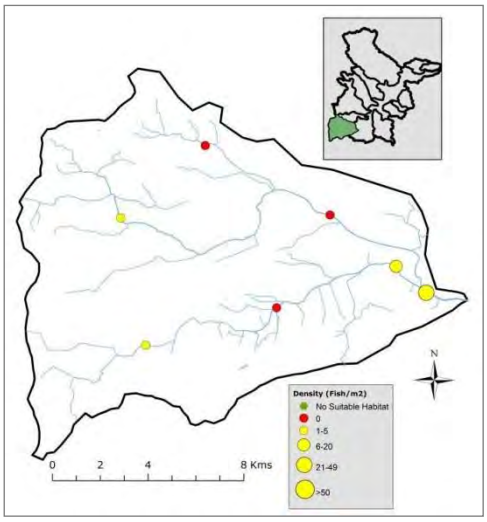


Figure 2.4 Length frequency distribution of *Lampetra* spp. ammocoetes (n=221) captured at locations across six sub catchments upstream of Trim in 2015.

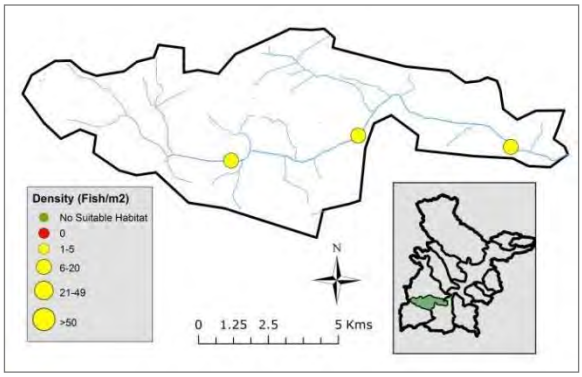
Plate 2.3. A section unsuitable for survey on the River Deel near Delvin, Co. Westmeath.



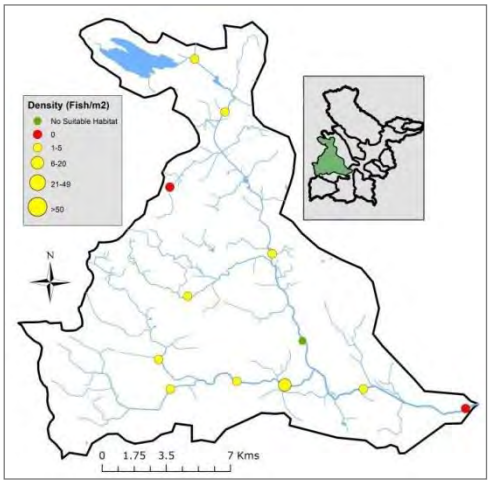
(1) Enfield/Longwood Blackwater



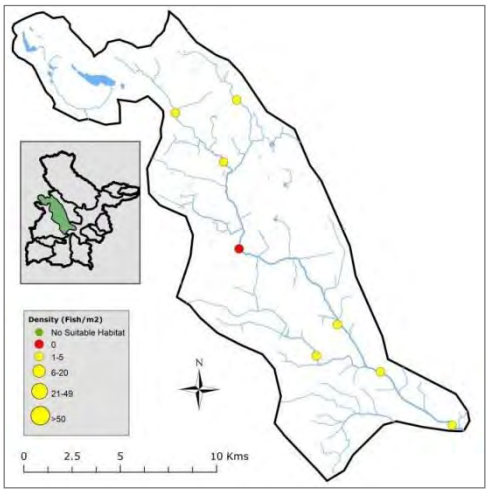
(2) Yellow/Castlejordan River



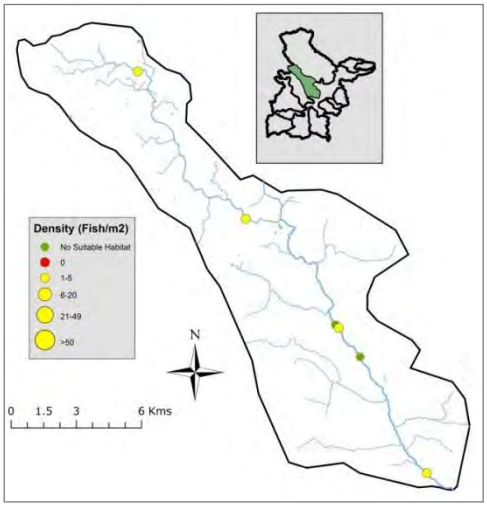
(3) Kinnegad/Kilwarden River



(4) Deel/Riverstown River



(5) Stoneyford



(6) Athboy/Tremblestown River

Figure 2.5. Sampling locations & results across six upstream Boyne sub catchments.

Kells Blackwater

The Kells Blackwater is the largest tributary of the Boyne. A significant portion of the drainage area of the main Kells Blackwater is situated upstream of Lough Ramor in Co. Cavan. The sub catchment comprises the smaller Moynalty River as well as the Navan Yellow River where adult brook lamprey were noted spawning in April 2015. Whilst a total of 29 sites were preselected, actual surveying was only possible at 27, of which 17 yielded positive results for *Lampetra* spp. ammocoetes (Figure 2.6).

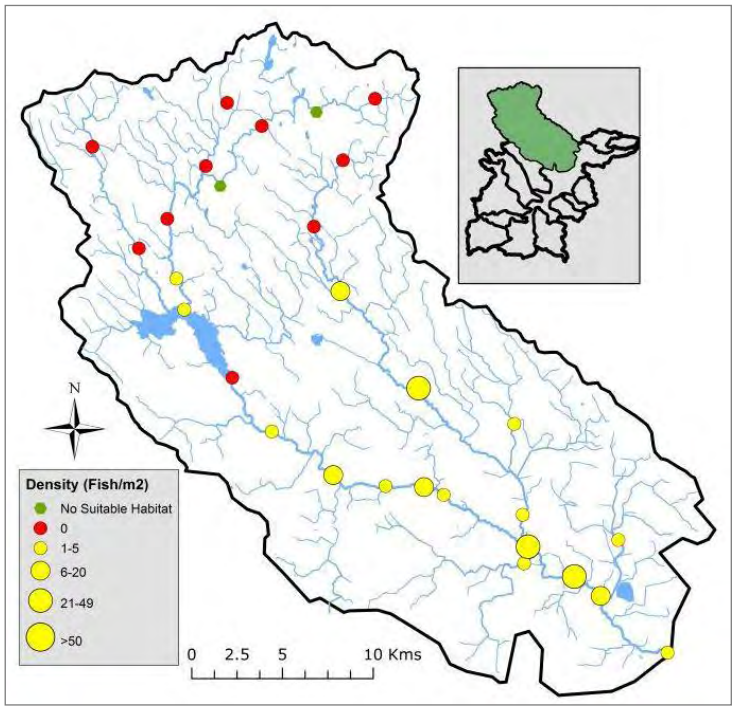


Figure 2.6. Sampling locations & results across the Kells Blackwater sub catchment.

Plate 2.4. The Kells Blackwater at Maudlin Bridge, Kells, Co. Meath

In all 182 specimens were captured, ranging in size from 22-152mm (Figure 2.7). Densities at positive sites varied from 1-42 ammocoetes per m^2 (Table 2.1). As with the initial 2005 survey, ammocoetes were largely absent above Lough Ramor, save for 2 locations in the immediate vicinity of Virginia, Co. Cavan (Figure 2.6).

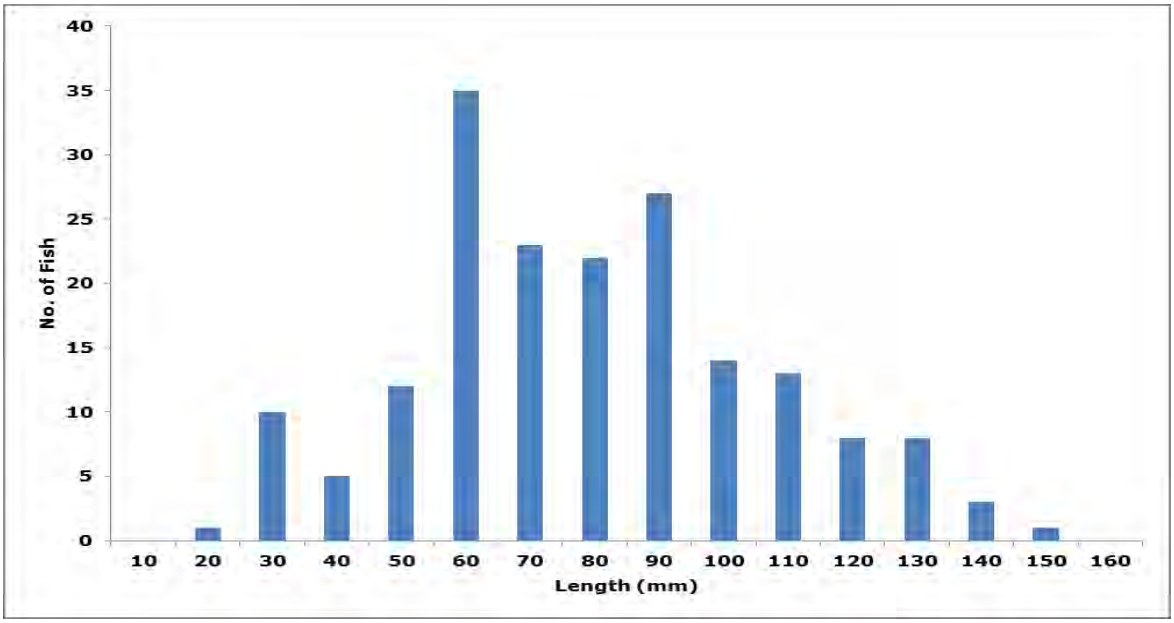


Figure 2.7. Length frequency distribution of *Lampetra* spp. ammocoetes (n=182) captured at locations across the Kells Blackwater sub catchment.

Plate 2.5. A positive site for ammocoetes at the inflow to Lough Ramor, Virginia, Co. Cavan.

Boyne Main Channel

A total of 23 sites were selected for survey along or in the immediate vicinity of the Boyne main channel. Survey sites were well-dispersed between Edenderry and Drogheda (Figure 2.8) and included locations on minor tributaries such as the Garr, Glash and Clady Rivers. Channel depth

and steep banks made for difficult electrofishing at number of the upper sites, whilst a site suitable for survey was impossible to locate in the environs of Navan town immediately upstream of the Kells Blackwater confluence.

Plate 2.6. The River Boyne midway between Trim and Navan at Bective, Co. Meath

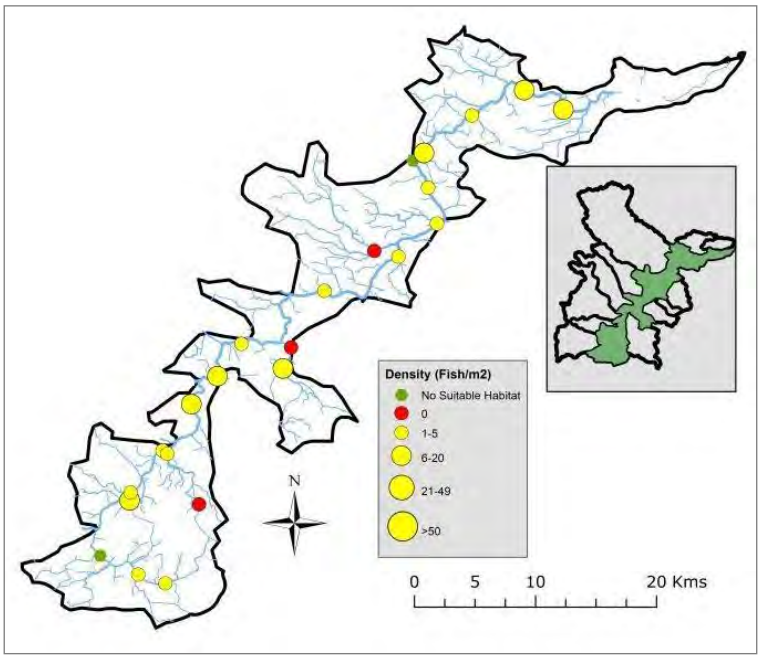


Figure 2.8. Sampling locations & results from along the main River Boyne.

Lampetra spp. ammocoetes (n=128) were obtained at 18 of the 22 locations electrofished (Table 2.1). Densities ranged from 1 to 15 individuals per m^2 (average = 7.1 ammocoetes m^{-2}). Lengths ranged from 17mm to 153mm (Figure 2.9). Highest densities (15 individuals per m^2) were encountered at two well-spaced locations, firstly at Inchamore Bridge midway between the Deel and Enfield/Longwood Blackwater confluences and secondly at Rossnaree, downriver of Slane, Co.

Meath. No *Petromyzon marinus* ammocoetes were recorded at this latter site, despite reports of sea lamprey spawning at several locations on the lower Boyne.

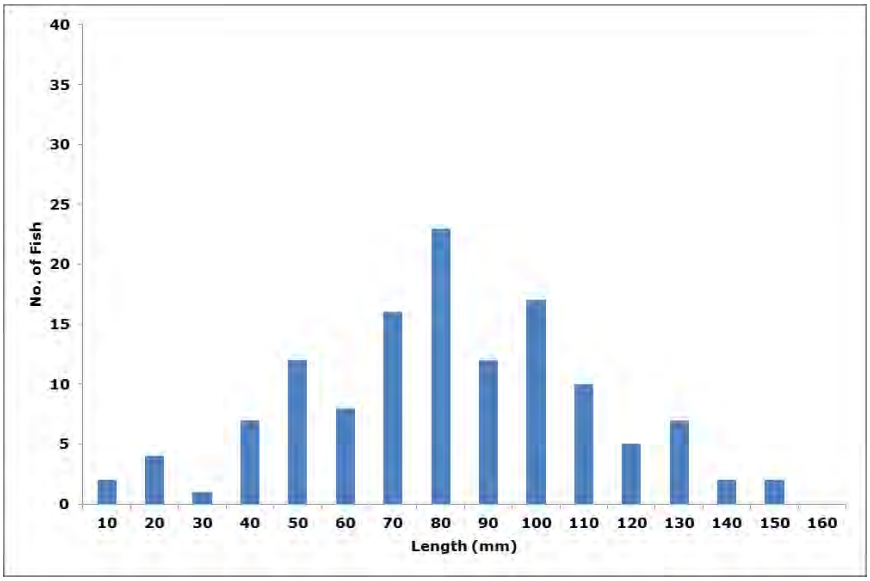
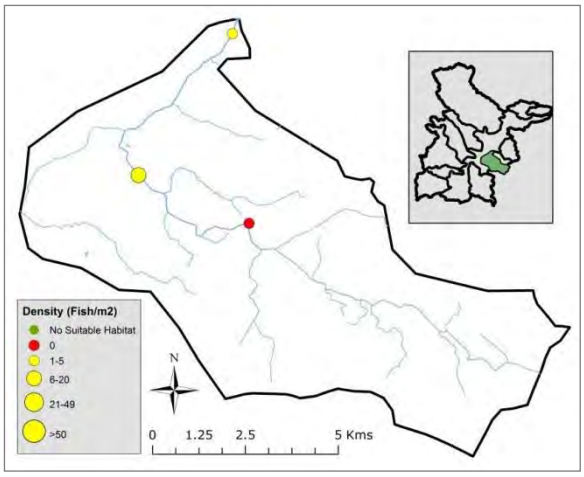


Figure 2.9. Length frequency distribution of *Lampetra* spp. ammocoetes (n=128) captured at locations along the River Boyne main channel.

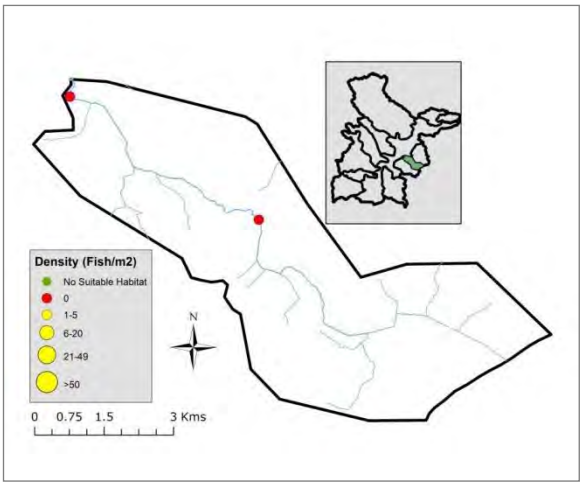
Plate 2.7. A positive site at Rossnaree, downstream of Slane, Co. Meath

Minor sub catchments downstream of Trim

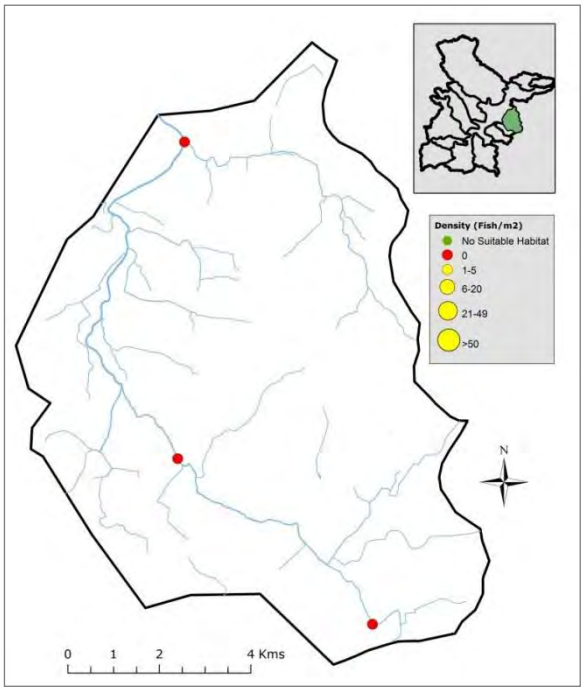
Four smaller sub catchments, the Knightsbrook, Boycetown, Skane and Mattock Rivers were surveyed with varying results (Figures 2.10.1-4). For completeness, two channels draining an area to the northeast of Drogheda and entering the Boyne Estuary downstream of the town were also surveyed (Figure 2.10.5).



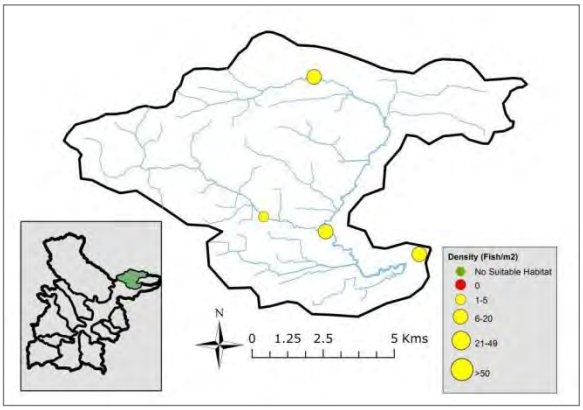
(1)Knightsbrook



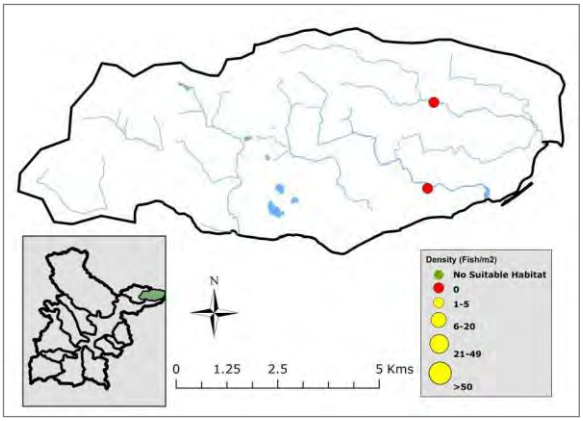
(2) Boycetown



(3) Skane



(4) Mattock



(5) North Drogheda

Figure 2.10. Sampling locations & results across five mid/lower Boyne sub catchments

The Knightsbrook and Mattock Rivers were the only sub catchments where ammocoetes were encountered. As regards the Knightsbrook, 2 out of the 3 sites surveyed were positive, with a density of 14 ammocoetes per m^2 recorded at Laracor, south of Trim. Four sites were surveyed across the Mattock sub catchment, including 1 site on the Devlin River. All 4 sites were positive with densities ranging from 4-15 individuals per m^2 (Table 2.1). The highest density ($15m^{-2}$) was noted at the lowermost site, 500m upstream of the confluence with the Boyne and immediately downstream of suitable spawning habitat where an adult *L. planeri* was observed in April 2015. Length-frequency profiles compiled for ammocoetes encountered across both sub catchments indicates presence of several age cohorts (Figure 2.11).

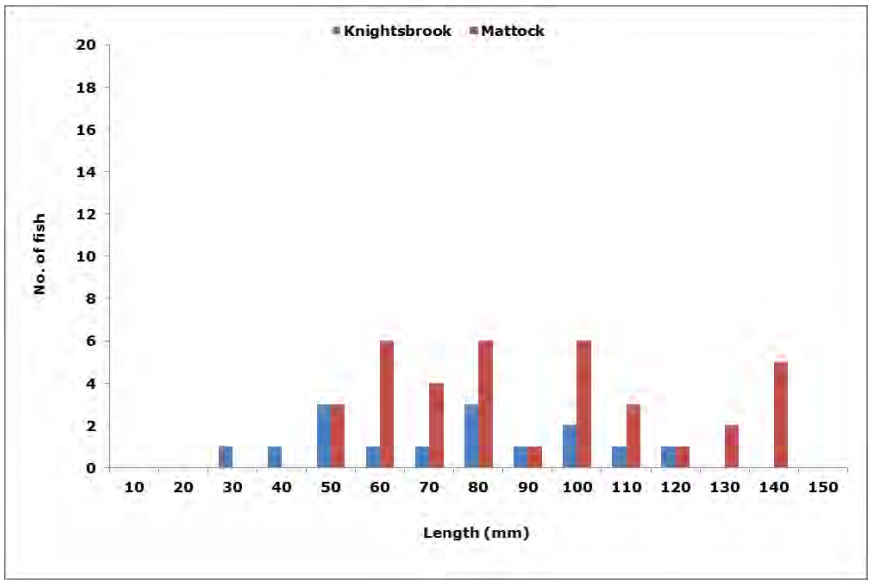


Figure 2.11 Length frequency distribution of *Lampetra* spp. ammocoetes captured on the Knightsbrook (n=15) and Mattock (n=37) sub catchments.

Plate 2.8. The Mattock River near Dowth on the Louth-Meath border.

Conclusions

Lampetra spp. larvae remain widely distributed across the Boyne catchment. Semi-quantitative electric fishing surveying was undertaken at 102 sites, with a wide geographic spread and broad representation of the range of habitat types available to larval lampreys. Ammocoetes were recorded at 73 sites (72%). Overall status can be considered favourable (Harvey and Cowx, 2003). Ammocoete densities in excess of $2m^{-2}$ were observed at 59 (81%) of positive sites, with 18 (25%) of these exceeding 10 individuals m^{-2}. A distinctive number of year classes (>2) were frequently observed in samples. However, no *P. marinus* ammocoetes were encountered.

Geographic distribution remains similar in 2015 when compared to that observed in 2005 (O'Connor, 2006). Ammocoetes continue to be absent from the Boycetown and Skane Rivers, as well as the upper reaches of the Kells Blackwater system. Distribution records are improved for a number of minor tributaries, namely the Yellow, Riverstown, Kinnegad, Athboy, Knightsbrook and Mattock Rivers.

Plate 2.9 Barrier to lamprey passage on the Kells Blackwater at Stramaquerty Bridge, Virginia, Co. Cavan.

2.1.2. Slaney Catchment Wide Ammocoete Survey

The Slaney rises in the Wicklow Mountains at Lugnaquilla Mountain. Its flows south west towards Stratford-on-Slaney and Baltinglass. The river then flows in a general south east direction to Wexford town where it enters the sea. The Slaney is 100 kilometres long and is tidal for 17 kilometres from the mouth of the river to Enniscorthy. There are five main tributaries of the River Slaney (Figure 2.12). The Bann joins the main channel approximately 12 kilometres upstream of Enniscorthy. The Urrin and the Boro merge with the main river downstream of Enniscorthy and drain the western area of the catchment. With regard to water quality in the Slaney and its tributaries, 52% of assessed river channel achieved good or high ecological status during the EPA's WFD surveillance monitoring for 2010 – 2012. Of the remaining channels, 40% were moderate and 8% were assessed as having a poor ecological status. The Slaney catchment area is characterised by intensively managed agricultural land. Diffuse pressures together with urban wastewater discharges have a negative impact on its water quality.

The River Slaney is a designated SAC for a number habitat types and species. These include:

- Estuaries
- Tidal Mudflats and Sandflats
- Floating River Vegetation
- Old Oak Woodlands
- Alluvial Forests
- *Margaritifera margaritifera* (Freshwater Pearl Mussel)
- *Petromyzon marinus* (Sea Lamprey)
- *Lampetra planeri* (Brook Lamprey)
- *Lampetra fluviatilis* (River Lamprey)
- *Alosa fallax fallax* (Twaite Shad)
- *Salmo salar* (Salmon)
- *Lutra lutra* (Otter)
- *Phoca vitulina* (Common Seal)

The River Slaney SAC is designated for all three species of lamprey and IFI is responsible for assessing population trends across all life stages of *Lampetra* spp. and *Petromyzon marinus*. The River Bann was chosen as a trend site and will be monitored on an annual basis for ammocoetes.

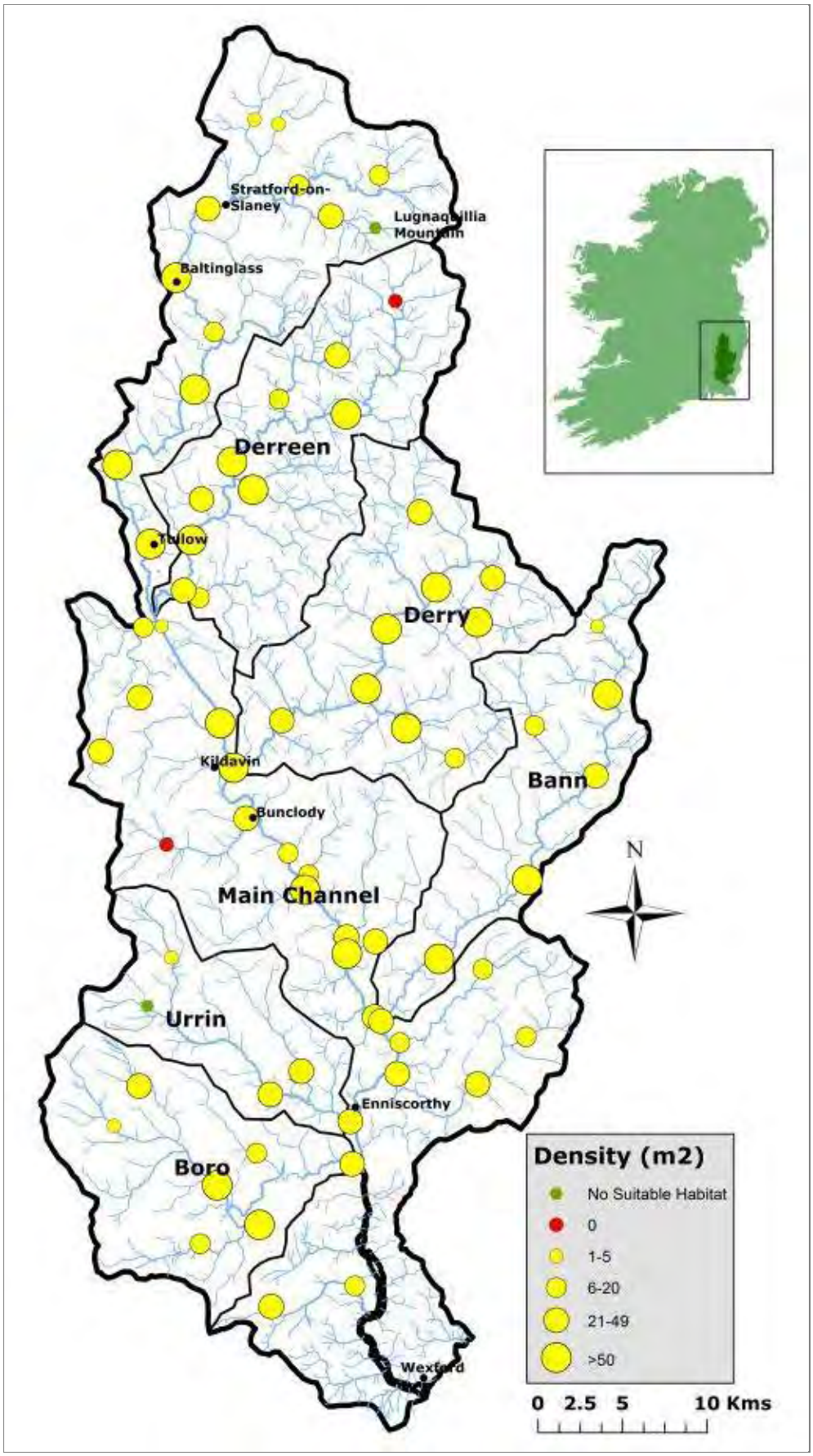


Figure 2.12. Map outlining sampling locations across the Slaney catchment for ammocoete densities, August/September 2015.

The Slaney catchment was sampled for juvenile lamprey between the 24th August and 22nd September 2015. In total, 72 sites were sampled in order to determine the density, distribution and population structure of the Slaney ammocoete community. Of the 72 sites sampled, juveniles were absent from only 4 sites. Two of these sites had no suitable ammocoete habitat in the form of fine sediment deposits.

Altogether 3097 *Lampetra* spp. ammocoetes were captured across the 68 positive sites sampled. No sea lamprey (*Petromyzon marinus*) larvae were recorded from the survey of the Slaney catchment. The length of fish surveyed varied between 6 and 173 millimetres (Table 2.2 and Figure 2.13) and results indicate a good population structure with all size classes represented. This would be indicative of recent recruitment and ongoing population regeneration. Across the catchment, 41 transformers were encountered, including those in an early stage of transformation. These transformers represented more mature individuals that would be due to spawn in early spring of 2016.

Table 2.2. Comparison of distribution, density, population structure of ammocoetes across the Slaney catchment, August/September 2015.

	No. Sites	No Suitable Habitat	No. positive Sites	Max. Density (Fish/m^2)	Min. Density (Fish/m^2)	Mean Density (Fish/m^2)	Max. Length (mm)	Min. Length (mm)
Main Channel (798km^2)	33	0	31	149	2	32.9 (n=1246)	139	13
Bann (176km^2)	7	0	7	96	1	43.4 (n=378)	120	6
Boro (177km^2)	7	1	7	82	1	32.6 (n=230)	151	15
Derreen (234km^2)	10	0	9	124	10	44.9 (n=407)	138	18
Derry (244km^2)	10	0	10	141	18	72.1 (n=746)	117	10
Urrin (116km^2)	5	1	4	37	2	21.3 (n=90)	173	16

All sites

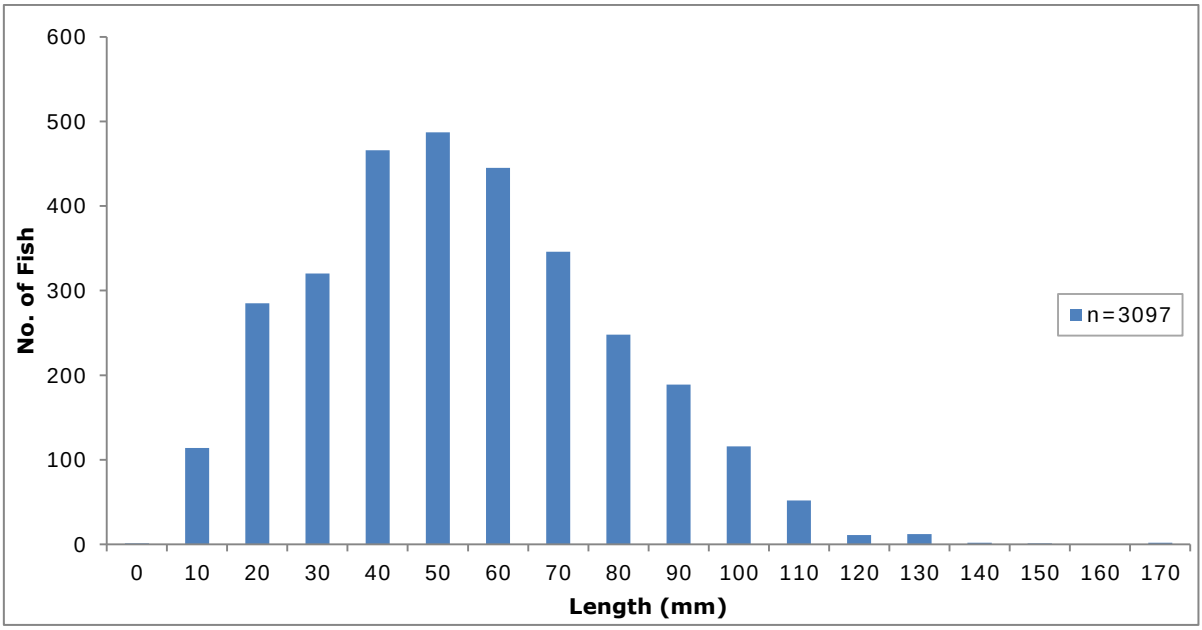


Figure 2.13. Length frequency of ammocoetes across all sites sampled in the Slaney catchment.

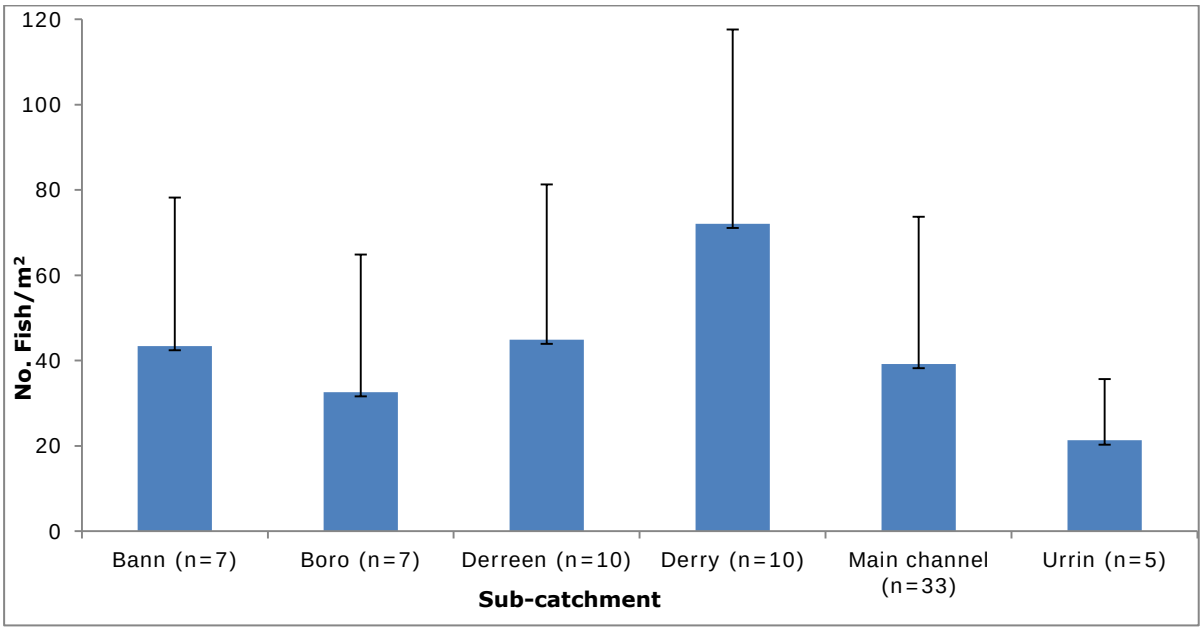


Figure 2.14. Mean densities of ammocoetes across sub catchments on the River Slaney, including Standard Deviation. (Only positive sites included in the calculation of mean values).

This sub-catchment comprised of the main channel of the River Slaney and a number of tributaries. This was the largest sub-catchment surveyed (798 km^2). In total 33 sites were examined across the River Slaney sub-catchment, including 12 sites on the main channel itself (Figure 2.15).

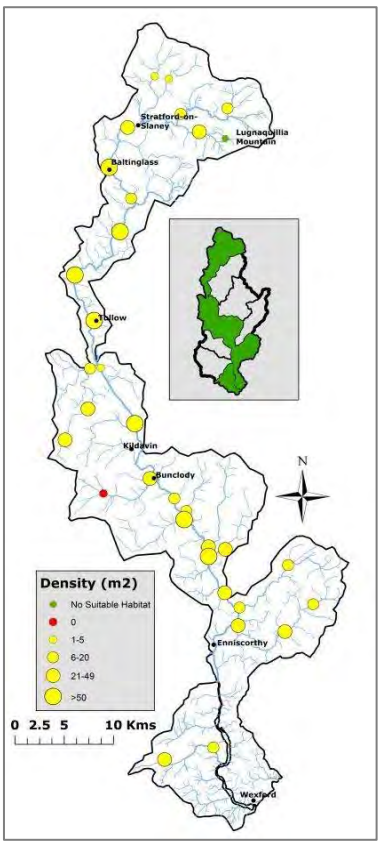


Figure 2.15. Sampling locations on the main channel sub-catchment.

The length of fish captured on the Slaney main channel sub-catchment varied between 13 and 139 millimetres (Figure 2.16).

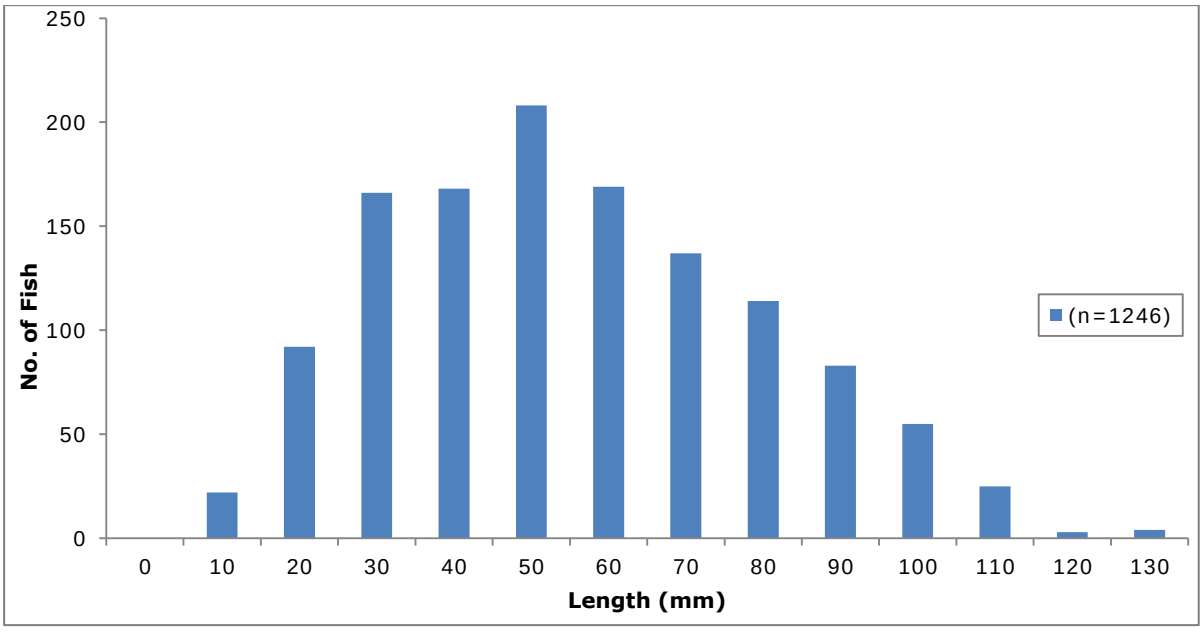


Figure 2.16. Length frequency of ammocoetes on the Slaney sub-catchment.

Ammocoetes were present at all sites sampled on the main channel with densities varying between 2 and 149 fish/m^2 (Figure 2.17).

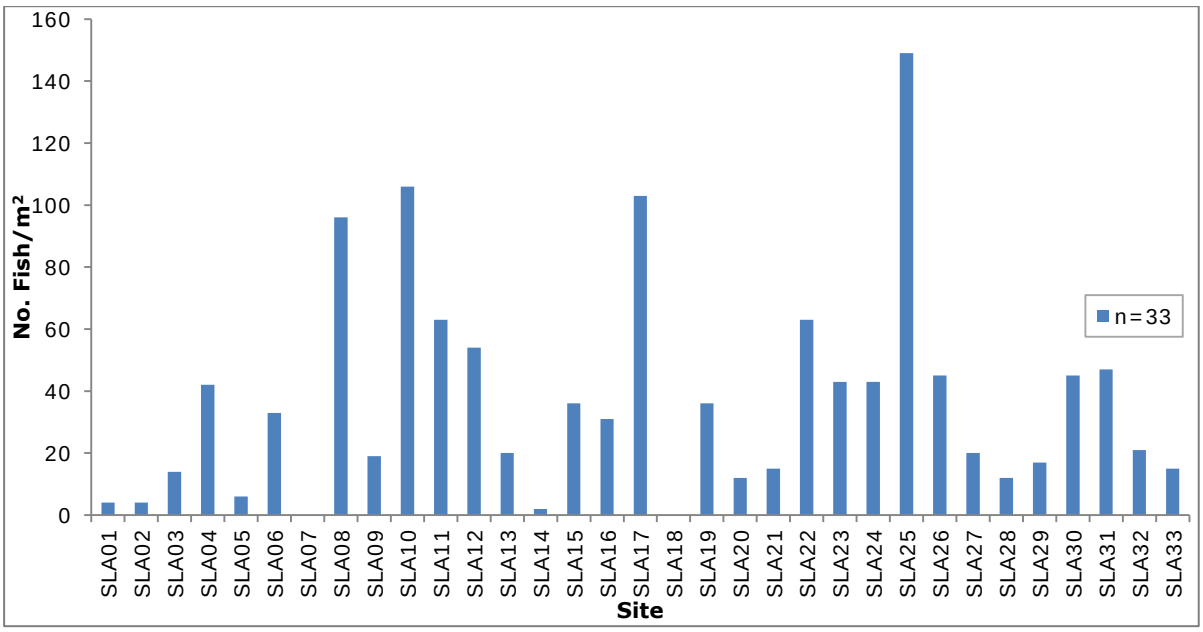


Figure 2.17. Density of ammocoetes on the Slaney sub-catchment.

The River Bann sub-catchment

The River Bann sub-catchment is situated to the east of the Slaney catchment (Figure 2.18).

Seven sites were sampled for ammocoetes, all of which were positive (Table 2.2 and Figure 2.18).

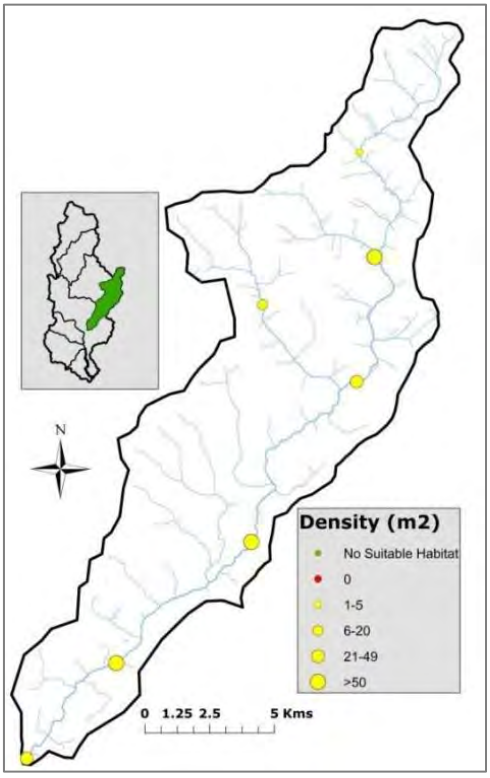


Figure 2.18. Sampling locations on the River Bann sub-catchment.

The length of juvenile lamprey captured on the Bann sub-catchment varied between 6 and 120 millimetres (Figure 2.19).

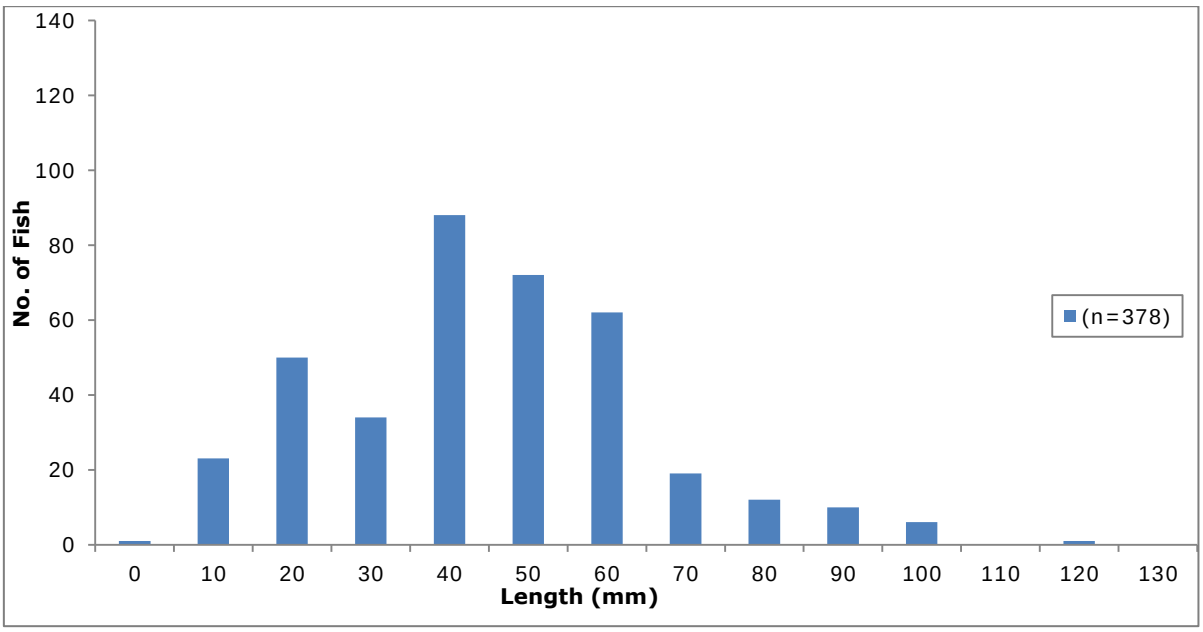


Figure 2.19. Length frequency of ammocoetes on the Bann sub-catchment.

The density of fish on the River Bann sub-catchment varied between 1 and 96 fish/m^2 (Figure 2.20).

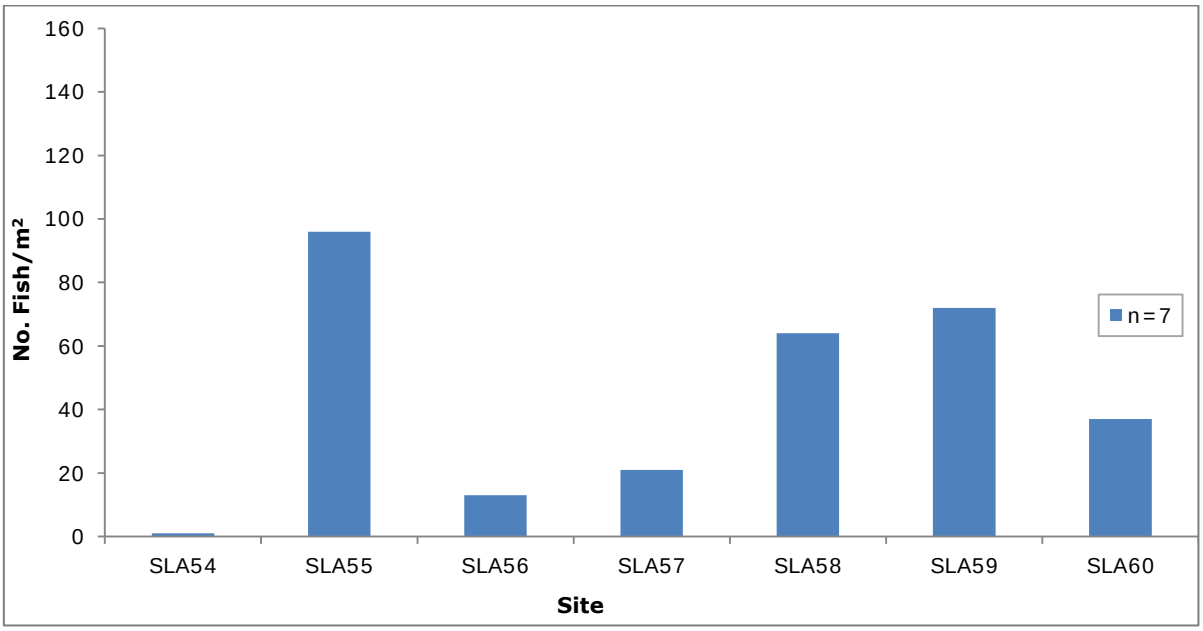


Figure 2.20. Density of ammocoetes on the Bann sub-catchment.

River Boro sub-catchment

The Boro sub-catchment is located in the south west of the Slaney catchment. Seven sites were sampled for ammocoetes, all of which were positive (Figure 2.21).

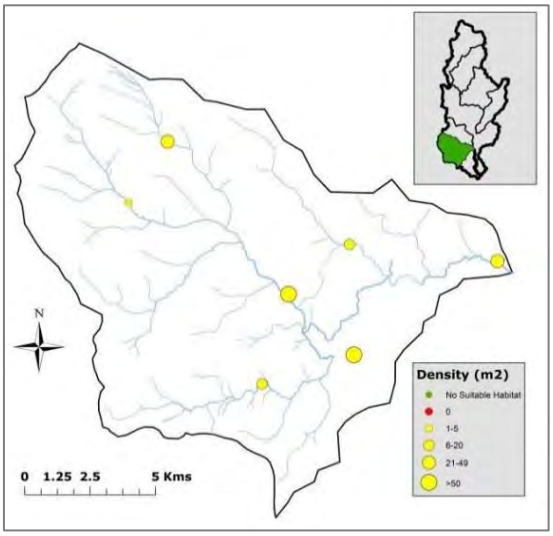


Figure 2.21. Sampling locations on the River Boro sub-catchment.

The length of ammocoetes varied between 15 and 151 millimetres (Figure 2.22).

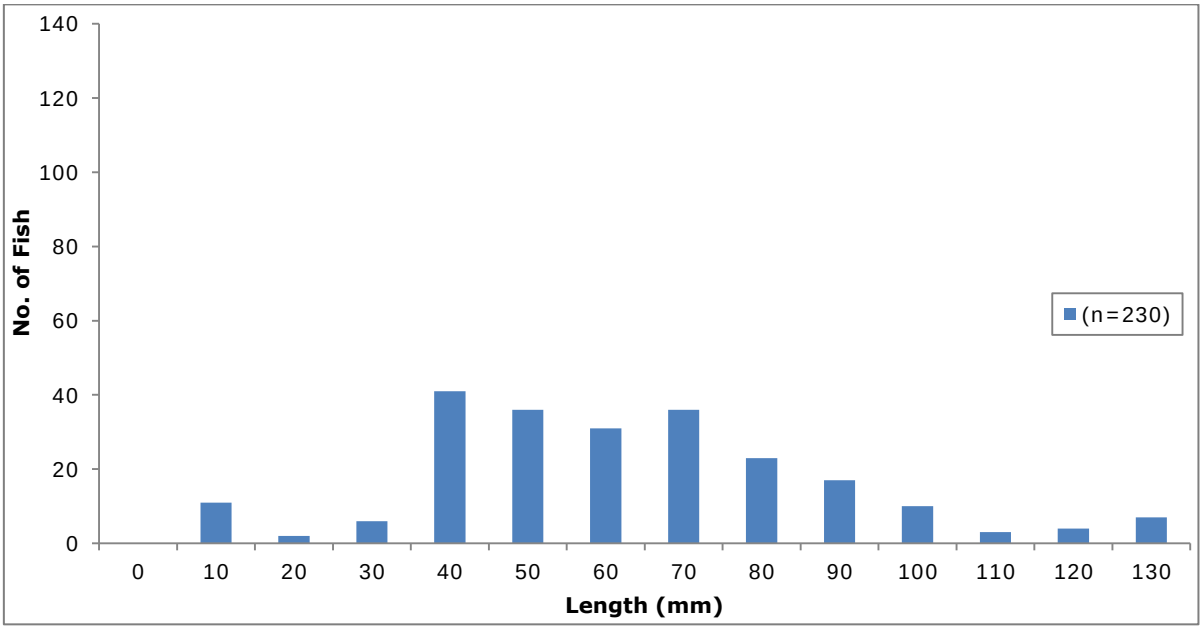


Figure 2.22. Length frequency of ammocoetes on the Boro sub-catchment.

The density of fish varied between 1 to 82 fish/m^2 (Figure 2.23).

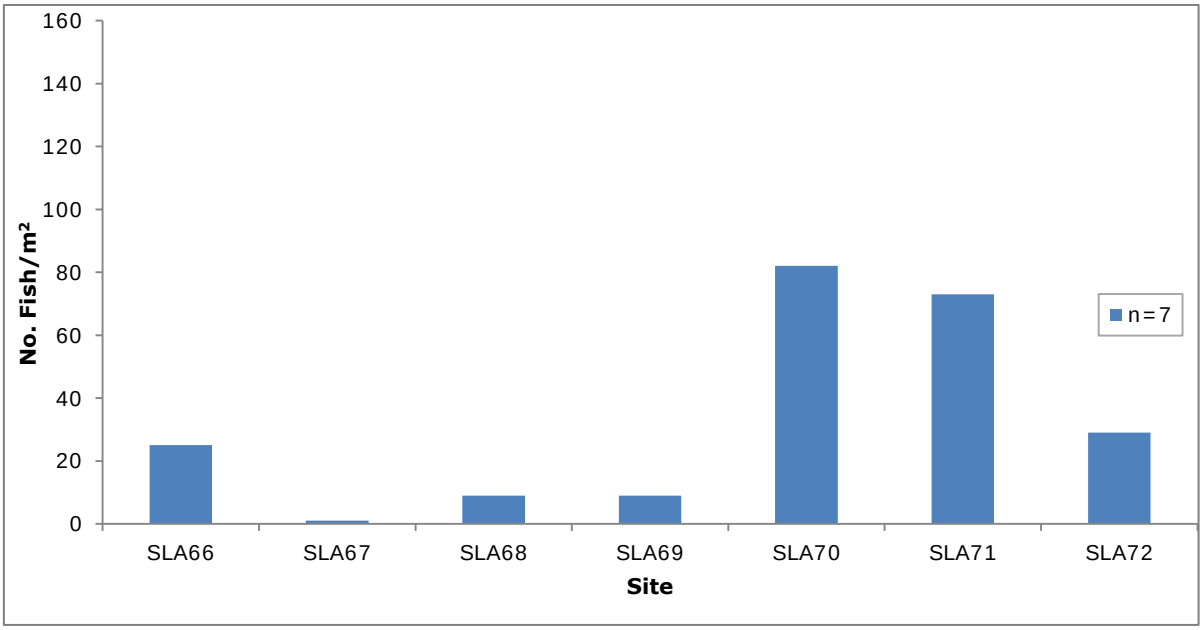


Figure 2.23. Density of ammocoetes on the Boro sub-catchment.

The Derreen sub-catchment

The Derreen sub-catchment is located in the north east of the catchment (Figure 2.24). Sampling was undertaken at 10 sights, of which ammocoetes were present at 9 sites.

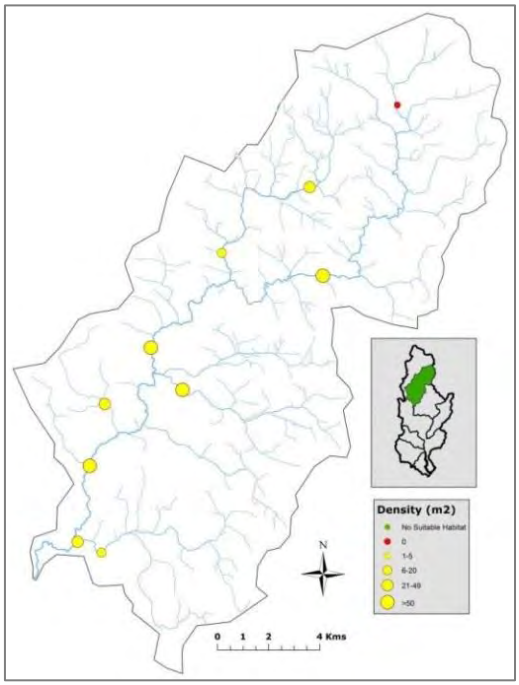


Figure 2.24. Sampling locations on the River Derreen sub-catchment.

The length of juvenile lamprey varied between 18 and 138 millimetres (Figure 2.25).

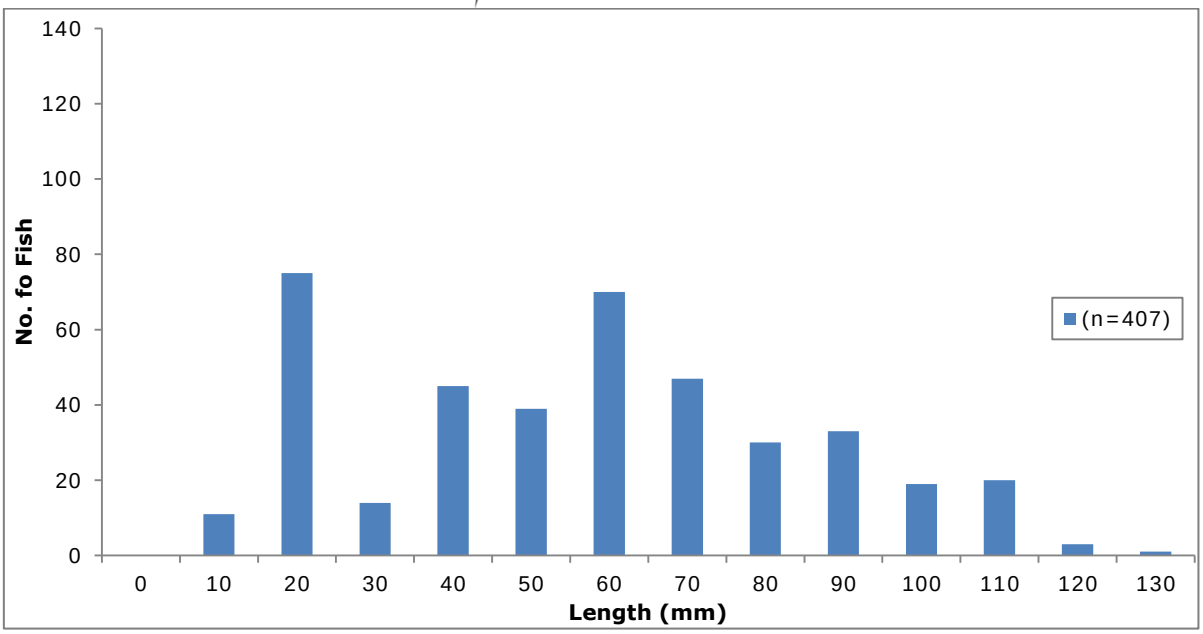


Figure 2.25. Length frequency of ammocoetes on the Derreen sub-catchment.

The density of ammocoetes on the Derreen sub-catchment varied between 9 and 124 fish/m^2 (Figure 2.26).

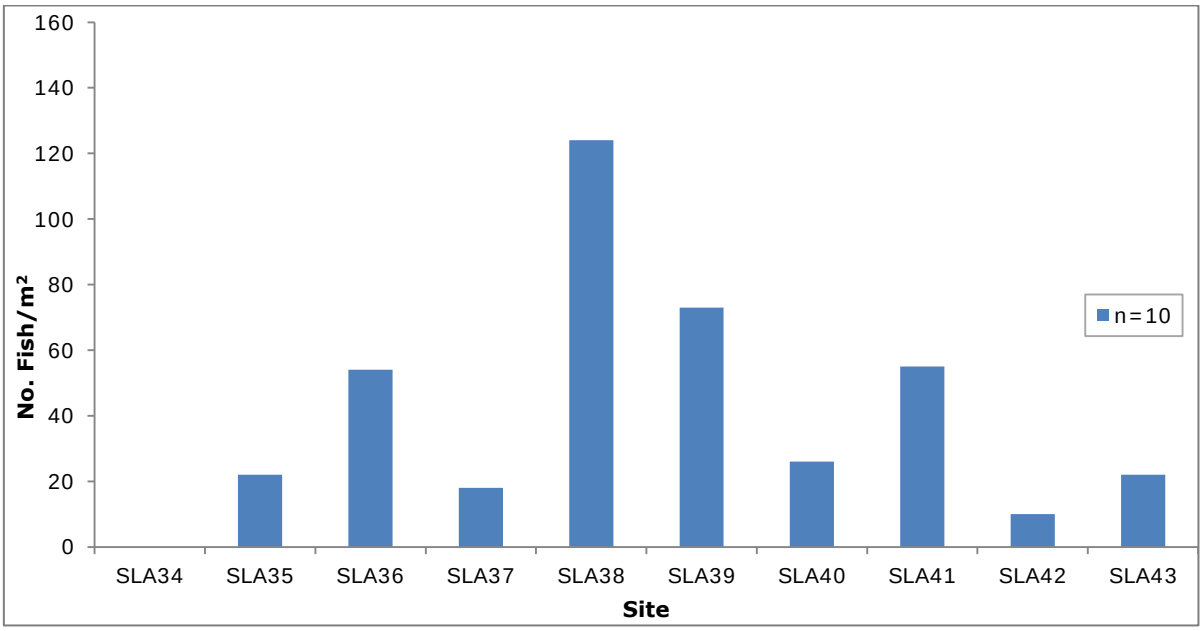


Figure 2.26. Density of ammocoetes on the Derreen sub-catchment.

The River Derry sub-catchment

The River Derry sub-catchment was sampled at 10 sites, all of which had juvenile lamprey present (Figure 2.27).

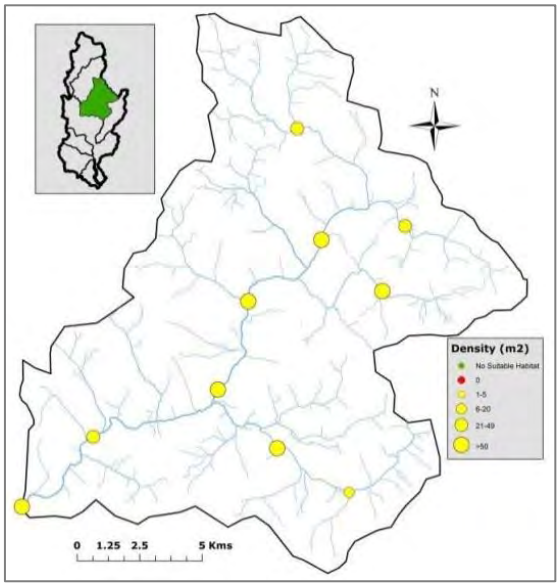


Figure 2.27. Sampling locations on the River Derry sub-catchment.

The length of juvenile lamprey varied between 10 and 117 millimetres (Figure 2.28).

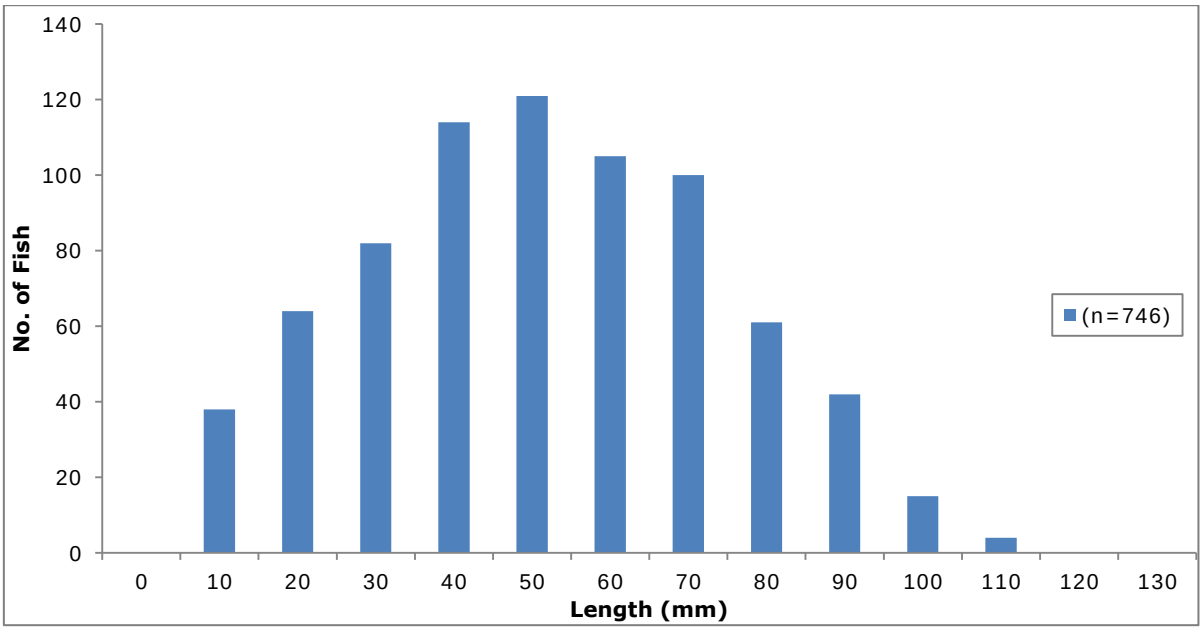


Figure 2.28. Length frequency of ammocoetes on the Derry sub-catchment.

The density of ammocoetes on the Derreen sub-catchment varied between 18 and 141 fish/m^2 (Figure 2.29).

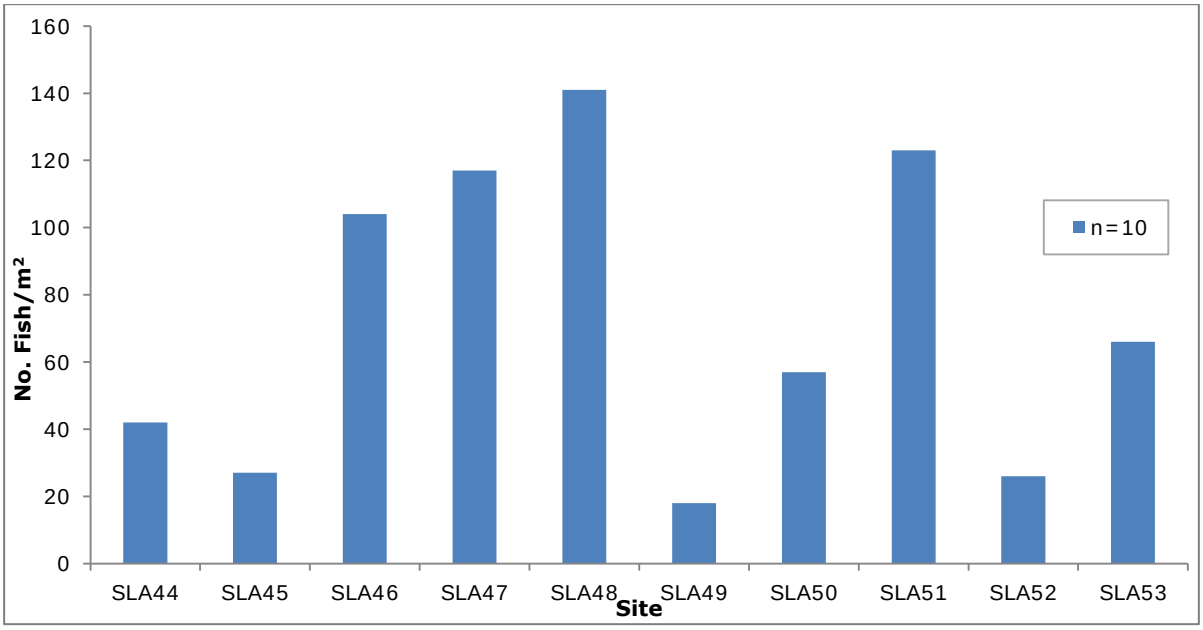


Figure 2.29. Density of ammocoetes on the Derreen sub-catchment.

The Urrin sub-catchment

The River Urrin sub-catchment was sampled at 5 sites, of which had 4 presented with juvenile lamprey (Figure 2.30).

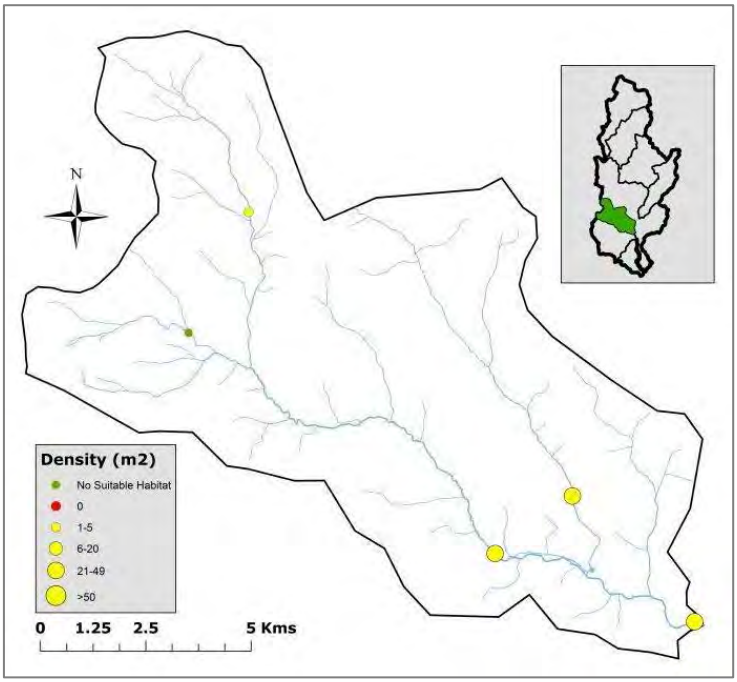


Figure 2.30. Sampling locations on the River Urrin sub-catchment.

The length of juvenile lamprey varied between 16 and 173 millimetres (Figure 2.31).

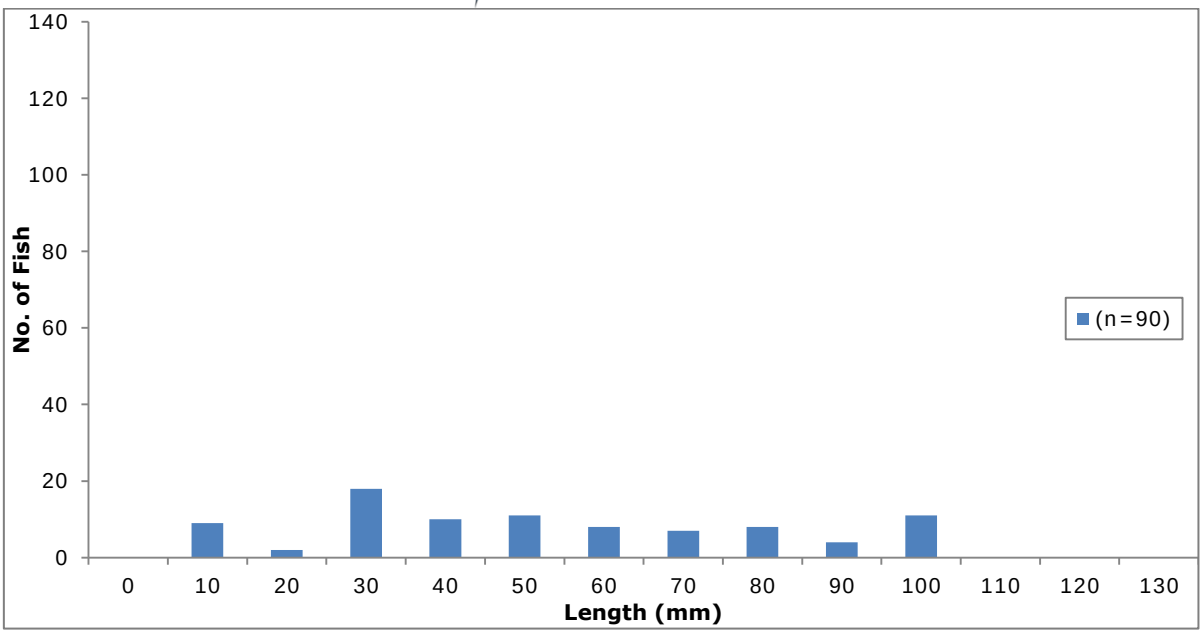


Figure 2.31. Length frequency of ammocoetes on the Urrin sub-catchment.

The density of ammocoetes on the Urrin sub-catchment varied between 2 and 37 fish/m^2 (Figure 2.32).

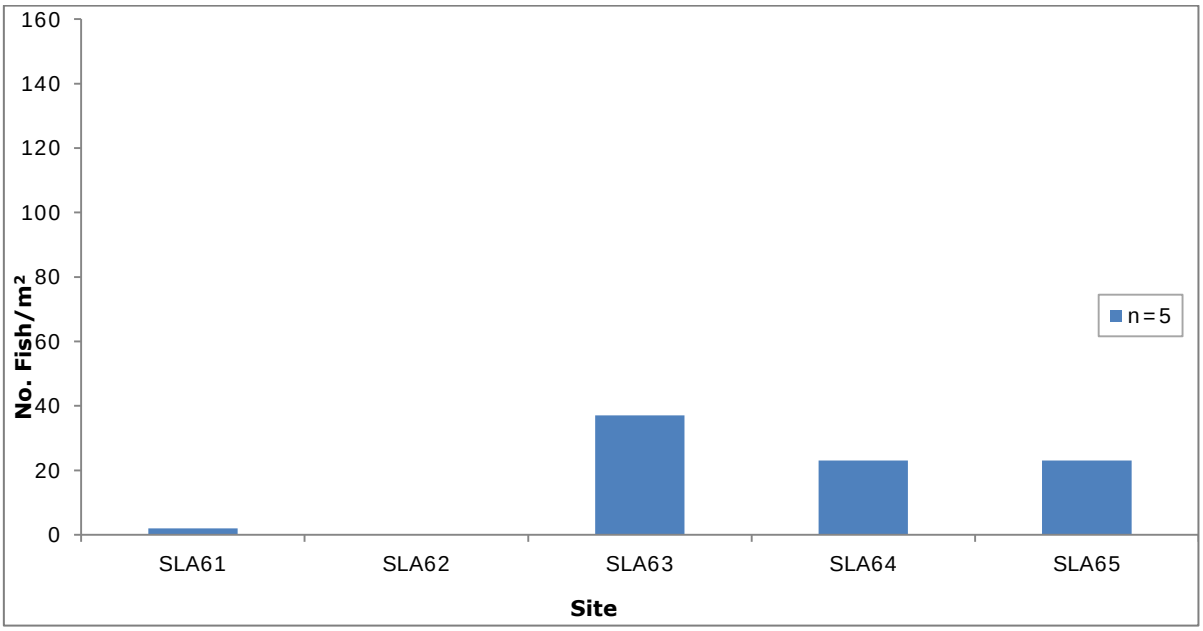


Figure 2.32. Density of ammocoetes on the Urrin sub-catchment.

The survey of the River Slaney SAC gave a very useful insight into the population structure, density and distribution of river/brook ammocoetes across the catchment. Several sites on the River Bann sub-catchment have been selected as index sites for trend analysis of ammocoete populations over time. These sites were electric fished in 2014 and 2015 and will be sampled on an annual basis over the coming years.

Length frequency analysis of the ammocoetes sampled during the survey indicated a suitable proportion of all size classes were present. *Lampetra* spp. ammocoetes were present at 94% of sites, indicating a wide distribution across the catchment. Harvey and Cowx, 2003 suggest that in

order to assess the conservation status of a catchment the density of ammocoetes should be greater than 2 fish per metre squared. Of the 6 sub-catchments sampled, all mean densities were above this recommendation. Ammocoete densities in excess of 2 fish/m^2 were observed at 97% of the positive sites, with 87% of these exceeding 10 fish/m^2. Given these results, Lampetra *spp* is at favourable conservation status in the Slaney catchment.

A similar ammocoete survey was undertaken in 2003, at which time 69 sites were surveyed. Of these, 23 were negative. In 2003, ammocoete densities in excess of 2 fish/m^2 were observed at 98% of the positive sites, with 54% of these exceeding 10 fish/m^2. The differences in the number of negative sites encountered between the two sampling occasions may be due sampling variation or there may have been a genuine increase in the population. Ongoing trend sampling of the River Bann index sites may clarify this further.

No sea lamprey ammocoetes were present in the samples collected across the catchment. IFI intend to survey the Slaney catchment during the summer of 2016 in an attempt to identify sea lamprey spawning activity within this SAC. A previous survey of sea lamprey spawning activity in 2010 identified Clohamon as the most upstream site for redd excavation. Redds were identified at approximately 20 locations between Clohamon and Enniscorthy at this time.

2.1.3 Ammocoete Reference Channels

Monitoring continued during 2015 across the network of 'Reference' or 'Index' channels, established in 2013 and intended to be surveyed annually or biennially over the six-year period up to 2018, providing scope for a more detailed trend analysis as stipulated for Article 17 reporting. Reference channels were selected to represent geographic range, stream order and water chemistry and the list includes those that displayed large populations of ammocoetes as well as those with adequate habitat but moderate or low presence of larval lamprey. A total of 24 reference channels were designated, of which 15 were visited during 2015 (Figure 2.33).

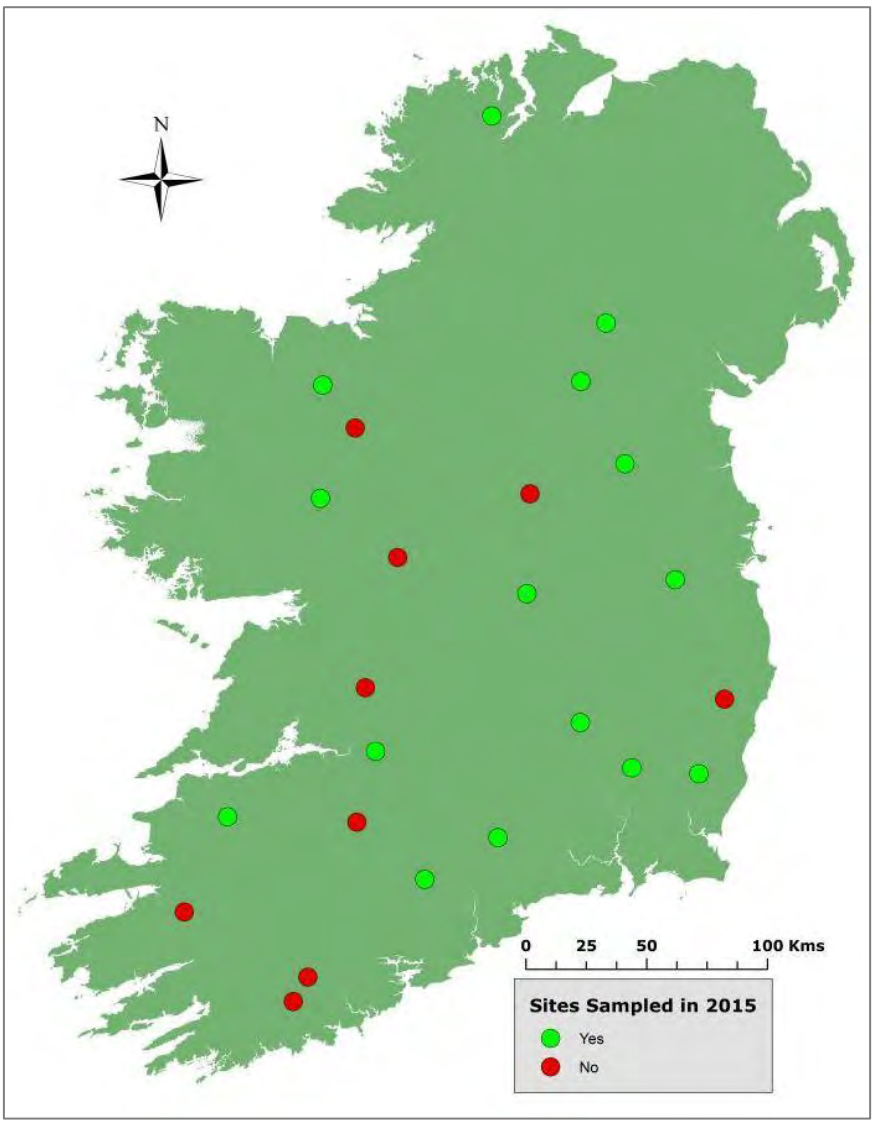


Figure 2.33. Location of larval reference channels throughout Ireland, with sites visited during 2015 indicated (green dots).

Preliminary Trend Analysis of larval lamprey data from the Annalee Index River

The Annalee River is located in the North Western River Basin District and forms part of the Erne Catchment. It rises at Lough Sillan near Shercock, Co. Cavan and follows a westerly course for over 60km to where it joins the Erne system at Lough Oughter near Butlersbridge. Lough Oughter and associated loughs is an SAC designated for natural eutrophic lakes, bog woodland and otter.

The Annalee has a large catchment area of 878km^2 and is joined downstream of Cootehill by a number of tributaries including the Laragh, Bunnoe and Dromore rivers (Figure 2.34). It drains agricultural pasture land and, in terms of water quality, 49% of river channel was at good ecological status, 38% at moderate and 13% was classified as poor in the EPA's WFD classification for the period 2010 – 2012 (http://gis.epa.ie/Envision).

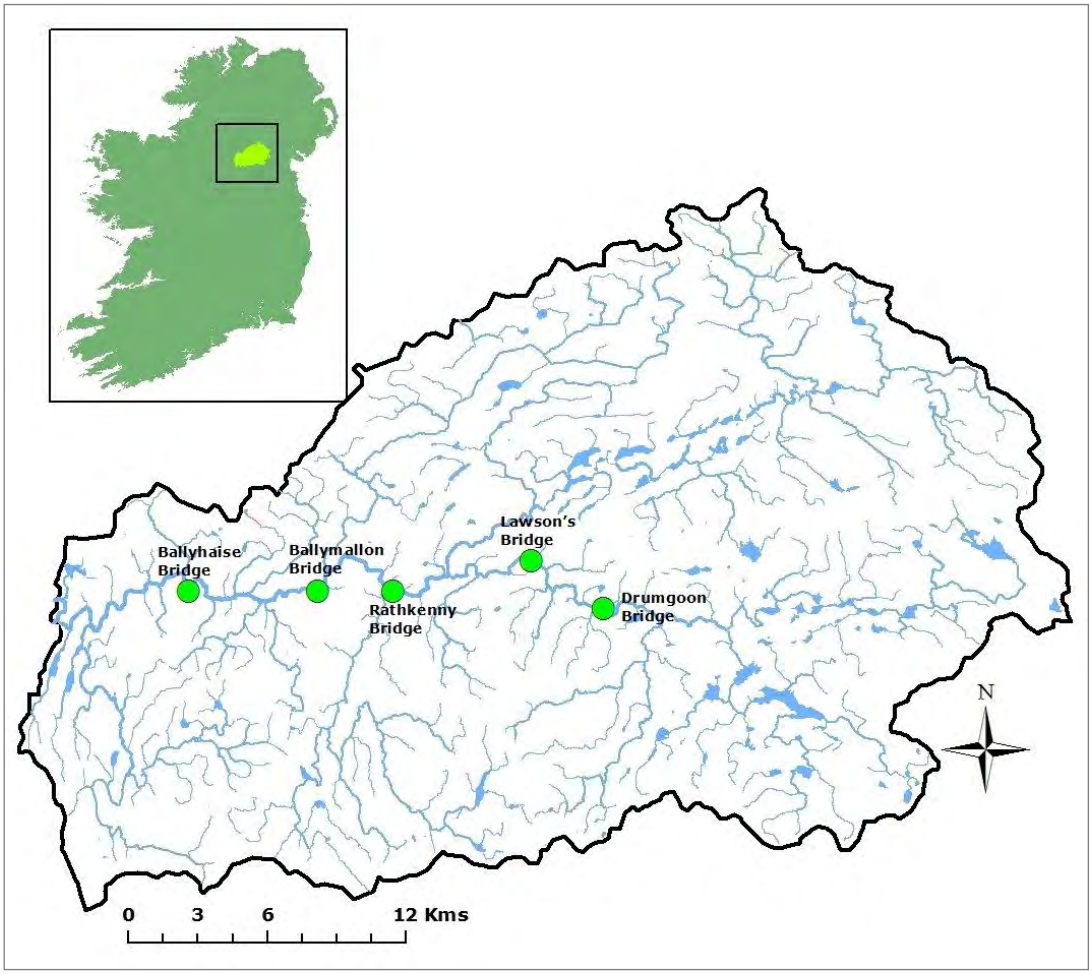


Figure 2.34. Map of the Annalee catchment showing index sites for lamprey ammocoetes.

A total of 5 sites on the main channel were surveyed annually for larval lamprey during 2013 – 2015 as part of the national monitoring programme of index or reference channels (Figure 2.34). Data are also available from a 2004 NPWS funded study, enabling a more long-term assessment of the lamprey population trend in this river. Median densities were slightly higher in 2014 and 2015 than in the preceding years (Figure 2.35). The majority of sites had more than $2m^{-2}$ ammocoetes in each year, suggesting that *Lampetra* spp. appears to be at good conservation status (Harvey and Cowx, 2003) in the Annalee. The highest density was recorded at Lawson's Bridge in 2014, when $43m^{-2}$ individuals were captured.

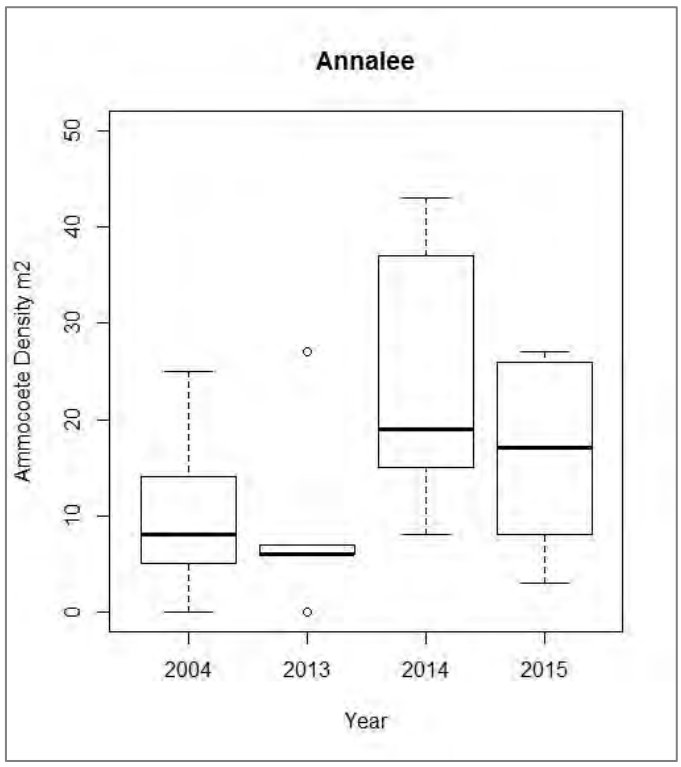


Figure 2.35. Whisker plots showing ammocoete densities from the Annalee (5 sites) in 2004 and 2013 – 2015. (The box in each whisker plot encloses the range from the 1st to the 3rd quartile. The solid line is the median density/2nd quartile for the 5 sites and the smallest and largest densities are represented as the tips of the whiskers).

Ammocoete lengths generally ranged between 50 – 100mm, with mean values between 65 – 80mm. Length distributions indicated recruitment each year, with both smaller and larger individuals represented in the population (Figure 2.36). Larger ammocoetes were recorded at Drumgoon Bridge, which is the most upstream site, in each of the 4 years.

Monitoring of ammocoete index sites only commenced in 2013, so there are limited data to assess temporal trends in population structure. For this reason, Generalized Linear Models (GLMs) were used to test for site and year effects on ammocoete density and length in the archived data from 2004, and from the recent surveys carried out in 2013–2015 (Figures 2.37 and 2.38). Subset models were compared (likelihood ratio tests) to test for overall site effects on each of density and length.

Results indicate that ammocoete density and length both varied significantly among sites (Chi-square, $P<0.001$). There was no consistent year effect on either density or length of ammocoetes, but there was a significant interaction between site and year for both descriptors. This result indicates that temporal changes in density and length varied among sites, and there was no overall trend between 2004 and 2015. Monitoring of the Annalee index river will continue on an annual basis during the 2018 reporting timeframe.

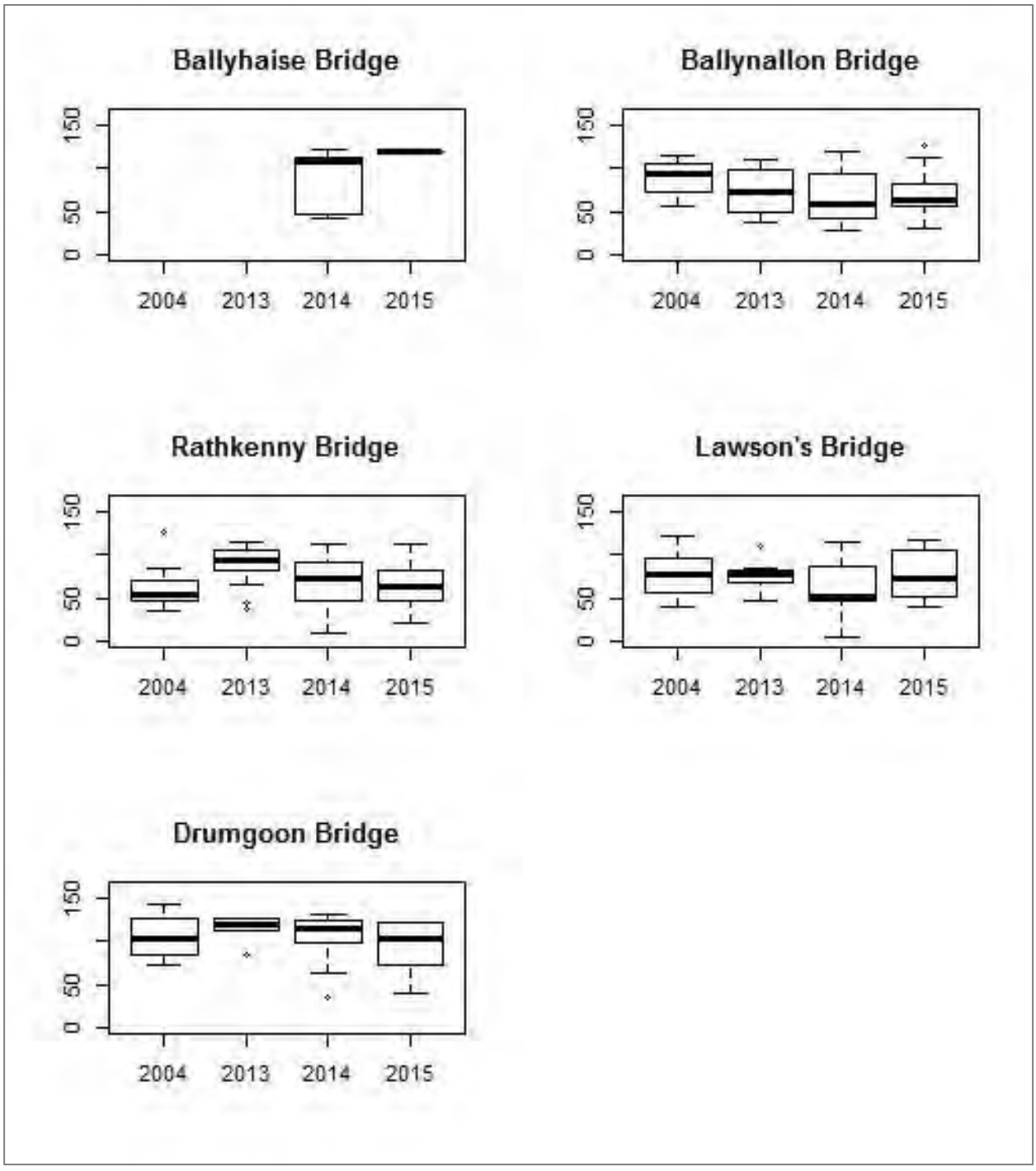


Figure 2.36. Ammocoete length data for sites on the River Annalee in 2004 and 2013 – 2015.

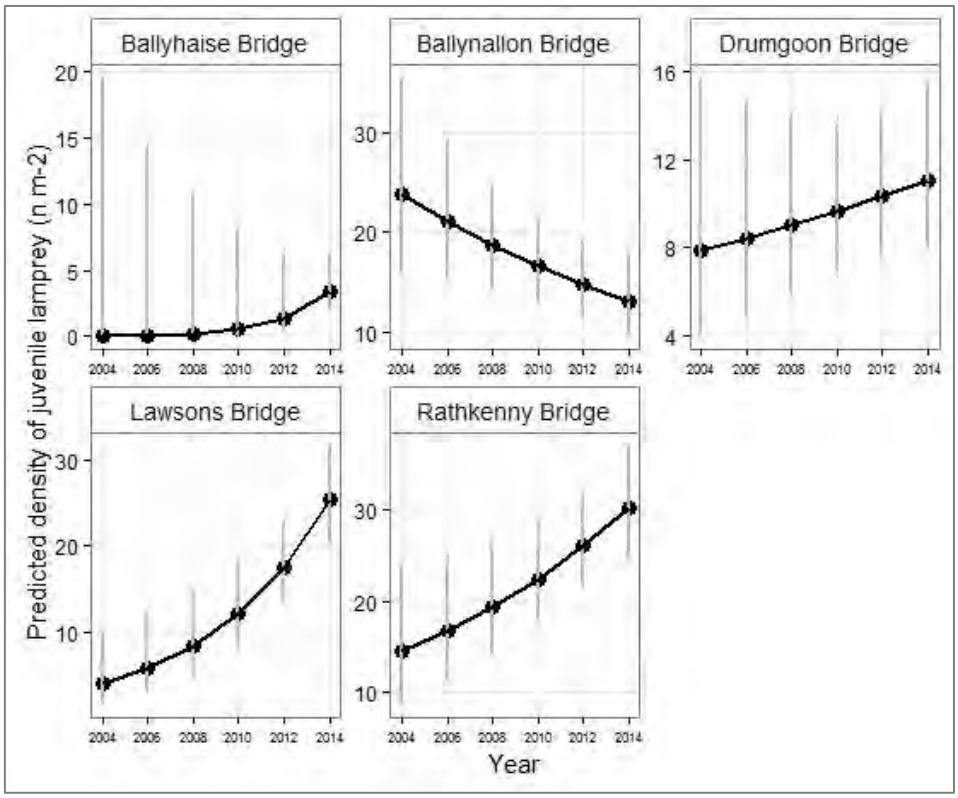


Figure 2.37. Predicted densities of ammocoetes in the Annalee for the period 2004–2015.

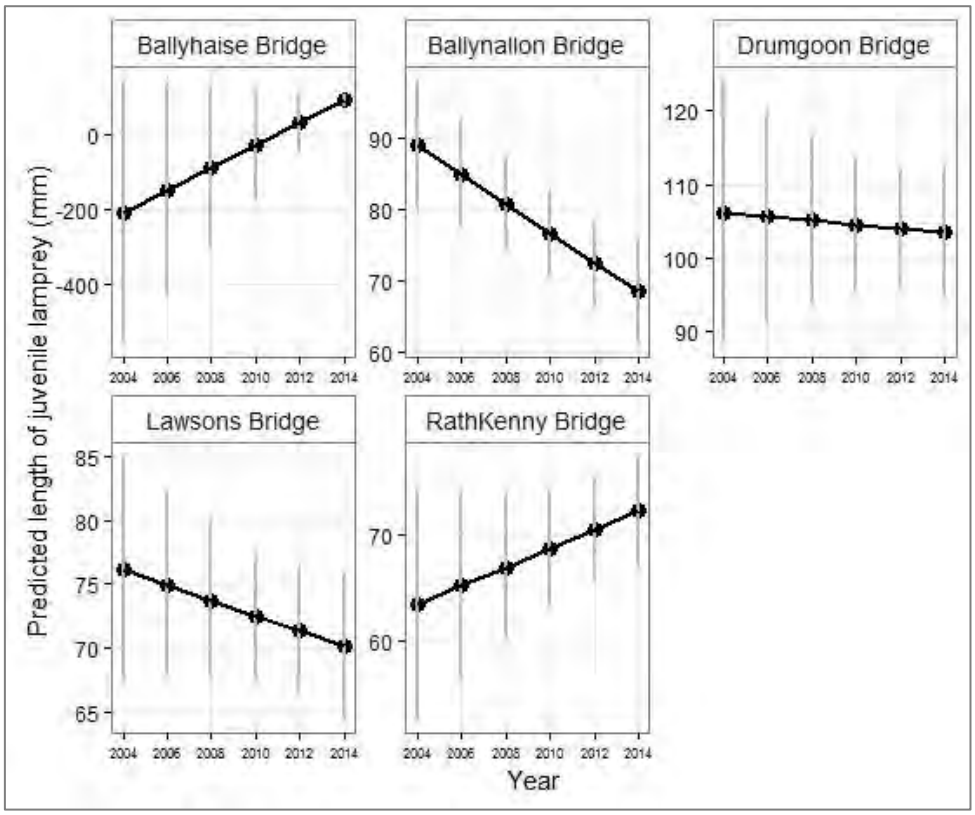


Figure 2.38. Predicted lengths of ammocoetes in the Annalee for the period 2004–2015.

2.2 Adult lamprey surveys

2.2.1 Monitoring Sea Lamprey Spawning Activity

During 2015 a number of sea lamprey spawning 'hot-spots' were visited, often repeatedly, to monitor and assess spawning activity.

2.2.1.1 Mulkear River

The Mulkear River at Annacotty, Co. Limerick was surveyed regularly during May, June and July 2015 both for red surveying and also in context of an IFI-supported sea lamprey eDNA post-doctoral study in UCD A 150m section, extending 100m downstream and 50m upstream of the old Annacotty bridge, was thoroughly searched during each visit, with counts compiled of all visible adult sea lamprey and redds present (Table 2.3). A maximum number of 52 adults were observed in late June, whilst a maximum of 122 individual nests were counted by early July. Spawning was noted after this date, however, redd counts were unreliable due to the high concentration, overlap and reuse of sea lamprey nests in this high activity area. Accompanying water temperatures increased from 13.2°C to 17.9°C from the end of May to the start of July.

Table 2.3. Sea lamprey spawning activity on the Mulkear River at Annacotty, Co. Limerick during May, June and July 2015.

Date	Sea Lamprey Count	Redd Count	Temperature (°C)
27/05/2015	1	0	13.2
10/06/2015	3	11	14.5
11/06/2015	22	21	14.6
18/06/2015	13	40	15.7
26/06/2015	52	77	16.7
02/07/2015	48	122	17.9
08/07/2015	24	Too numerous &	17.9
24/07/2015	16	compound to count	15.7

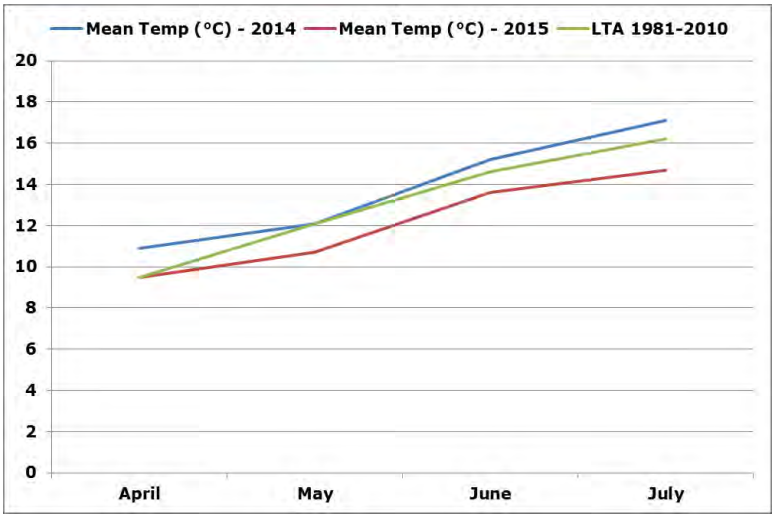
2.2.1.2 Other Locations

A number of recognized sea lamprey spawning 'hot spots' were visited, often on several occasions, during 2015 (Table 2.4). Expansive spawning was noted on the River Fergus in Ennis Town, in particular along the Newbridge Road / Steele's Rock section. Spawning was also recorded on the River Shannon in the grounds of UL at Plassey and on the Owengarney River in Sixmilebridge, Co. Clare (Plate 2.10). Redds were also in evidence along sections of the Munster Blackwater at Fermoy and Mallow, Co. Cork. No redds were observed on the Kilmastula at Birdhill, the Feale at Duagh Bridge, the Suir in Clonmel or the Nore at Thomastown. Repeat visits were not possible at a number of these locations due to water conditions, etc. No sea lamprey activity was noted during an initial visit to St. Mullins on the River Barrow on June 5th. Activity was reported in this area by regional IFI staff later that month (June 23rd).

Table 2.4. Sea lamprey spawning activity across a number of recognised 'hot spots' during May, June and July 2015.

Date	Location	Sea Lamprey	Redds	Temp (°C)
11/06/2015	River Shannon, UL Living Bridge, Plassey, Co. Limerick	0	1	15.3
02/07/2015		24	compound	18.6
26/05/2015	River Fergus, Ennis Town, Co. Clare	0	0	15.6
10/06/2015		3	1	16.4
11/07/2015		Spawning activity reported by Clare Co. Co.		
17/07/2015		Spawning activity reported by Clare Co. Co.		
24/07/2015		0	35	16.9
26/05/2015	Owengarney River, Sixmilebridge, Co. Clare	0	0	16.0
10/06/2015		0	1	18.0
18/06/2015		3	3	16.8
24/07/2015		0	13	17.2
17/06/2015	Kilmastula River, Birdhill, Co. Tipperary	0	0	15.5
24/06/2015	River Feale, Duagh, Co. Kerry	0	0	19.5
25/06/2015	M. Blackwater, Mallow, Co. Cork	0	1	16.2
25/06/2015	M. Blackwater, Fermoy, Co. Cork	0	9	16.5
12/06/2015	Clonmel, Co. Tipperary	0	0	14.5
29/07/2015		0	0	NA
05/06/2015	River Nore, Thomastown, Co. Kilkenny	0	0	14.3
05/06/2015	River Barrow, St Mullins, Co. Carlow	0	0	15.5
23/06/2015	River Barrow, St Mullins, Co. Carlow	Spawning activity reported by IFI staff		

In general, sea lamprey were observed building redds from early June. Activity was observed over several weeks, with individuals still noted on the Mulkear on July 24th. After a wet May, both June and July 2015 remained cooler than average (Figure 2.39), possibly allowing for a protracted spawning season. Meteorological data were obtained from a weather station at Shannon Airport, Co. Clare, the data from which should be broadly representative of the Lower Shannon area.



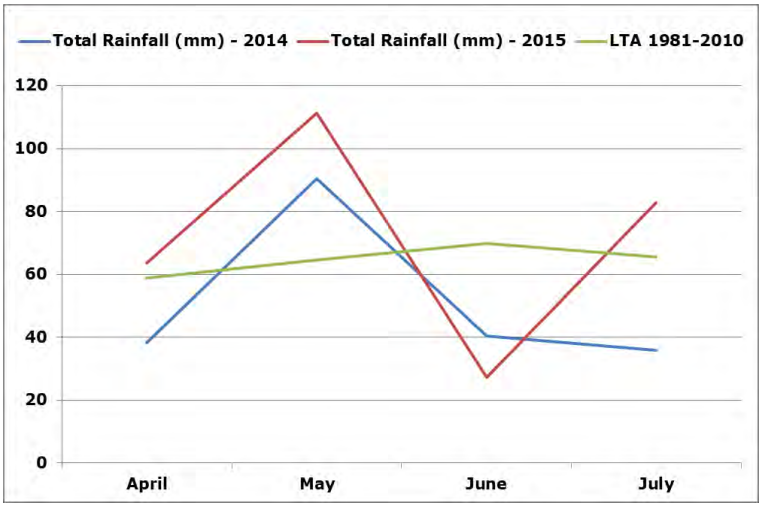


Figure 2.39. Monthly mean air temperatures (a) and total rainfall (b) from April to July over consecutive years (2014 & 2015) recorded at Shannon Airport (Met Eireann) in comparison with the 30 year (1981-2010) long-term average (LTA).

Plate 2.10. Sea lamprey redds on the Owengarney River, Sixmilebridge, Co. Clare

2.2.2 Collection of Environmental DNA (eDNA)

Many threatened species exist at low densities and are difficult to detect or monitor. The potential to sample for species-specific environmental or 'eDNA' may help to mitigate this problem (Thomsen *et al.* 2012). Environmental DNA monitoring is an emerging genetic technique which, by analysing water samples for miniscule traces of DNA, allows the detection of species, thereby supporting effective deployment of limited conservation resources. Collection of samples to screen for presence of sea lamprey eDNA commenced in 2015 across two catchments, namely the Mulkear and the Munster Blackwater.

2.2.2.1. Mulkear River

Sampling was conducted within the Mulkear River Catchment, part of the Lower Shannon Special Area of Conservation (SAC) for sea lamprey. Water samples were taken at 9 well-dispersed sites across the Mulkear catchment (Figure 2.40). Sampling points were chosen according to previous records of sea lamprey activity and were usually situated 500m-1km downstream of historical spawning locations. A negative field control sample was taken from a location within the Mulkear River drainage region on the Annagh River above Clare Falls, a significant barrier to upstream migration), from where no records of sea lamprey exists. Sampling commenced in late May (27/5/2015) before sea lamprey had commenced spawning in the Mulkear. Samples were taken on 5 subsequent occasions throughout the spawning period as well as one sample taken post spawning. Sampling sites were as follows;

1) Bilboa Bridge, Bilboa River (MLK01)
2) New Bridge, Bilboa River (MLK02
3) Clonsingle Bridge, Annagh River (MLK03)
4) Ballymakeogh Bridge, Newport River (MLK04)
5) Killeenagarriff Bridge, Killeenagarriff River (MLK05)
6) Abington Bridge, Mulkear River (MLK06)
7) Scart, Mulkear River (MLK07)
8) Annacotty, Mulkear River (MLK08)
9) Sunville Bridge, Dead River (MLK09)
10) Above Clare Falls (Negative Control)

All samples were collected from mid-river locations approximately 20 cm below river surface. Samples collected were kept in a cool box during transportation and then frozen at -20°C. Samples will be processed during 2016. DNA will be extracted from the stored samples and amplified to target sea lamprey specific sequences through qPCR (quantitative Polymerase Chain Reaction) to confirm presence and concentration of sea lamprey eDNA. This method is based on the protocol outlined by Gustavson *et al.* (2015). Furthermore during 2016, one of the sampling sites will be selected and intensive sampling will be carried out during the spawning season to calibrate eDNA concentration with numbers of sea lamprey present.

Widespread walkover surveying was undertaken across the catchment to quantify the extent and scale of *P. marinus* spawning during 2015, especially given the limited migration potential due to damage suffered to the lamprey-specific ascension tiles fitted to the face of Annacotty weir. Small numbers of redds were detected on the Bilboa upstream (n=2) and downstream (n=1) of Cappamore and on the Mulkear at Abington (n=1) and Scart (n=1). Single carcasses were also observed at Cappamore and Scart, respectively (Plate 2.10). A number of structures (n=6) were observed on the Killeenagarriff River between Killeenagarriff Bridge and Barrington's Bridge, however it could not be determined if these were redds from 2015 or 2014. No redds or carcasses were detected from other locations upstream of Annacotty weir, principally along sections of the Newport, Annagh and Dead Rivers where high levels of spawning were observed in 2014. In contrast, extensive sea lamprey spawning activity was recorded downstream of Annacotty weir (Table 2.3).

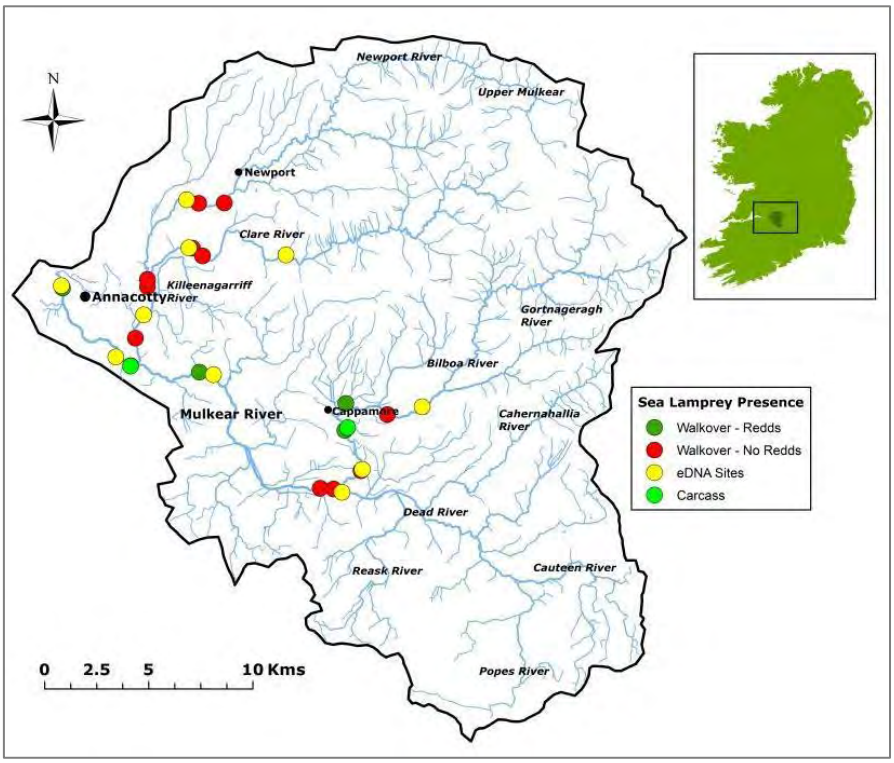


Figure 2.40. Sampling locations on the Mulkear.

2.2.2.2. Munster Blackwater

Samples were collected at locations throughout the Munster Blackwater catchment in June 2015 during the period of sea lamprey migration and spawning. This sampling will serve as a preliminary baseline survey prior to a planned weir removal project envisaged for the catchment in 2016. The efficacy of the weir removal towards amelioration of sea lamprey upstream migration into the upper catchment will be assessed *via* collection of eDNA, redd counting and telemetry. Initial sampling for eDNA was undertaken at 10 sites along the main stem of the Munster Blackwater in Co. Cork, along with a negative control sample taken at Ballydesmond on the Cork/Kerry border, at the upper limits of the catchment where there are no records of *P. marinus.* Sampling sites were as follows;

1) Newmarket (2014 ammocoete survey site MBW1)- Negative control (MBW01)
2) Lisheen Bridge (2014 ammocoete survey site MBW4) (MBW02)
3) Duncannon Bridge(MBW03)
4) Ford near Millstreet (2014 ammocoete survey MBW10) (MBW04)
5) Ballymaquirk Bridge (MBW05)
6) Lombardstown Bridge (MBW06)
7) d/s Mallow (Mallow Bridge at castle) (MBW07)
8) Ballyhooly Bridge (MBW08)
9) d/s Fermoy Town Weir (MBW09)
10) Ballyduff Bridge(MBW10)
11) Cappoquin (Hut Pool) (MBW11)

All samples were obtained during a single day (June 25th) in a similar manner to that on the Mulkear (Plate 2.11). Freshly excavated sea lamprey redds were observed during sampling at two locations, namely Mallow (n=1) and Fermoy (n=9).

Plate 2.11. Collecting water samples for eDNA analysis from the Bilboa River, Co. Limerick.

Plate 2.12. A sea lamprey carcass on the Bilboa River, Cappamore, Co. Limerick.

2.2.3 Munster Blackwater Floatover Survey of Sea Lamprey Spawning Habitat

The Munster Blackwater (MBW) is a designated SAC for Twaite shad and for river, brook and sea lamprey. As a facet of reporting on Annex II fish species under the Habitats Directive, IFI is required to monitor the adult phase of the sea lamprey life cycle. Sea lamprey spawn in areas of well oxygenated gravel beds and the enumeration of redds in these spawning areas is both cost-effective and non- invasive. Although redd counting is not an exact science, and can be subjective, an indication into activity of sea lamprey may be gained from doing such surveys. Using canoes, a floatover survey of the MBW was undertaken on 16th and 17th July 2015 to investigate spawning activity between Ballyhooly Bridge (Figure 2.41) and the Kitchen Hole (downstream of Lismore). Once an area of suitable habitat was encountered, the area was examined and the number of redds was recorded (Figure 2.41). GPS (Global Positioning Survey) locations were taken at the beginning and end of each area of suitable spawning habitat so that the length of river could be calculated using ArcView GIS.

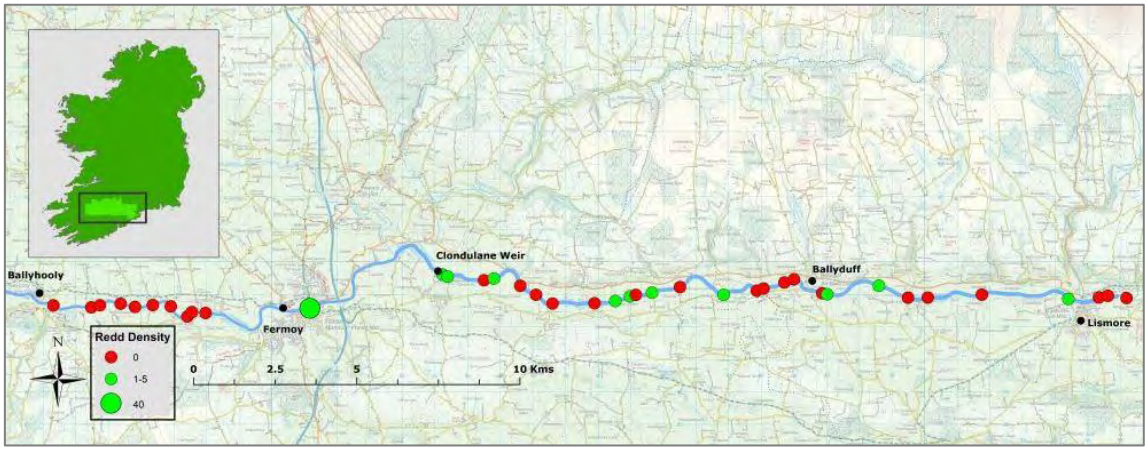


Figure 2.41. Map displaying density values for sea lamprey redds on the MBW.

In total, almost 40 kilometres of river was surveyed for sea lamprey redds. There are weirs at Clondulane and Fermoy which hinder the upward migration of sea lamprey (Plate 2.13). From Ballyhooly to Fermoy, 10 areas of suitable habitat were present. However, no redds were recorded in these areas. The river, for approximately 4 kilometres upstream of Fermoy and 5 kilometres upstream of Clondulane weir, is impounded. In these sections the water is very deep and slow flowing with no natural spawning habitat or riffles. Immediately downstream of Fermoy there was a large area of suitable spawning habitat. At this location 40 redds were identified. Five sea lamprey were also spotted in the area undertaking redd excavation. No suitable habitat was present between Fermoy and Clondulane. Immediately downstream of Clondulane Weir, two areas of suitable habitat revealed a total of five redds. In the 22 kilometres surveyed downstream of Clondulane, 11 out of 29 areas of suitable habitat showed signs of spawning activity. A total of 22 redds were recorded in these 11 areas, with numbers varying between 1 and 4 redds at any particular location.

Plate 2.13. Fermoy and Clondulane Weirs, respectively.

2.2.4 Sea Lamprey Telemetry Paper

For migratory species such as sea lamprey, access to suitable spawning and nursery habitats throughout a catchment will serve to increase population resilience and counteract the potential effects of unpredictable and adverse environmental conditions. *P. marinus* is one of a number of lamprey species worldwide considered threatened or in decline across their native range, with stream regulation and imposition of obstacles identified as a major contributory factor (Renaud 1997; Russon *et al.* 2011). Barrier removal or mitigation measures to facilitate passage are considered essential in the context of conservation status of sea lamprey in Irish SACs.

A manuscript outlining the sea lamprey radio tracking work undertaken on the Mulkear River during 2010 and 2011 was accepted for publication during 2015. Entitled 'Behaviour of sea lamprey (*Petromyzon marinus* L.) at man-made obstacles during upriver spawning migration: use of telemetry to assess efficacy of weir modifications for improved passage', the paper details the behaviour of radio tagged sea lamprey (n=87) in the lower section of the Mulkear catchment. Of particular interest was their response to manmade obstacles both before and after structural

adaptations incorporated as part of the EU-funded Mulkear LIFE project, aimed specifically to improve upstream migration. As well as demonstrating improved upstream passage into the catchment for some individuals, the downstream relocation by other tagged sea lamprey to alternative spawning areas was also noted. The full citation is as follows:

Rooney, S.M.,Wightman,G.D., O Conchuir, R. and King, J.J. (2015) : Behaviour of sea lamprey (*Petromyzon marinus* L.) at man-made obstacles during upriver spawning migration: use of telemetry to access efficacy of weir modifications for improved passage. *Biology and Environment : Proc. R. Ir. Acad.* 115 B, 1-12.

Plate 2.14. A radio tagged sea lamprey prior to release

2.2.5 River Lamprey Surveys

2.2.5.1 River Boyne Catchment

The live trapping exercise to monitor river lamprey spawning migration, initiated at locations across the River Boyne catchment during November 2014, was continued into 2015. Traps, similar to those used in UK studies (Morris and Maitland,1987), deployed at locations (Figure 2.42) on the Mattock (n=2), Yellow (n=1) and Tremblestown (n=1) rivers and main stem Boyne at Bective Bridge (n=2), were checked at least fortnightly between early January and late April 2015.

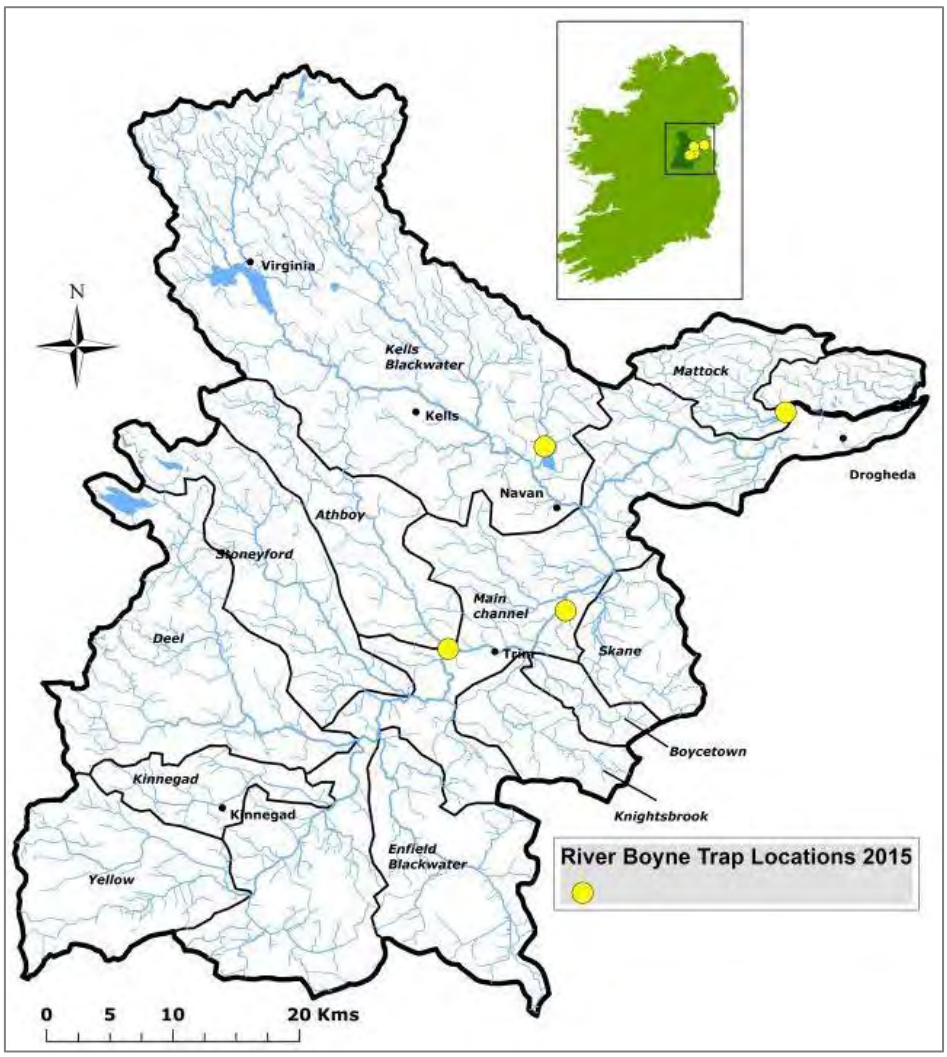
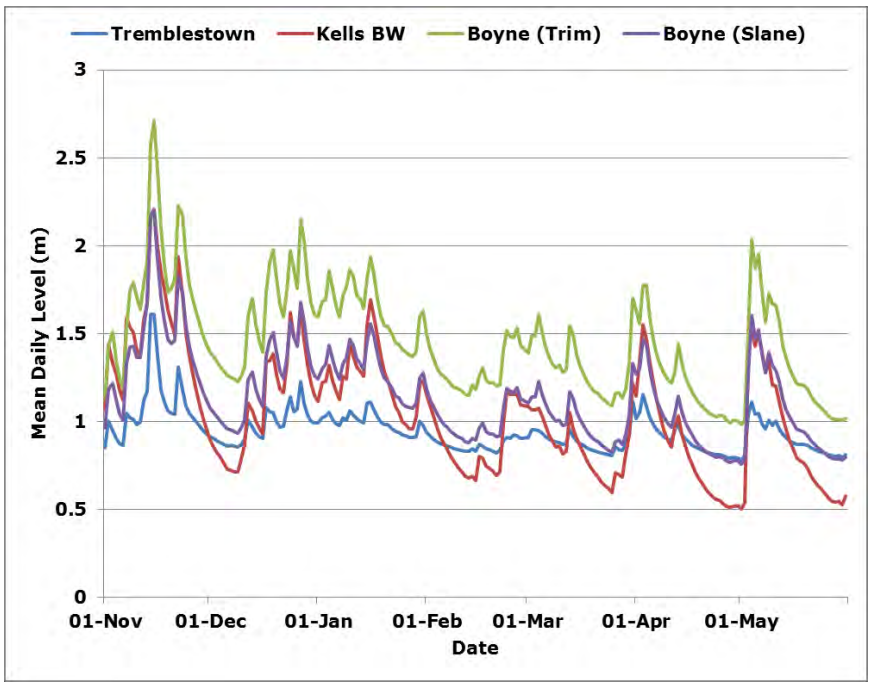


Figure 2.42. River lamprey trapping locations across the Boyne catchment, November 2014 to April 2015.

Plate 2.15. A river lamprey trap on the Yellow River, a tributary of the Kells Blackwater.

(a)



(b)

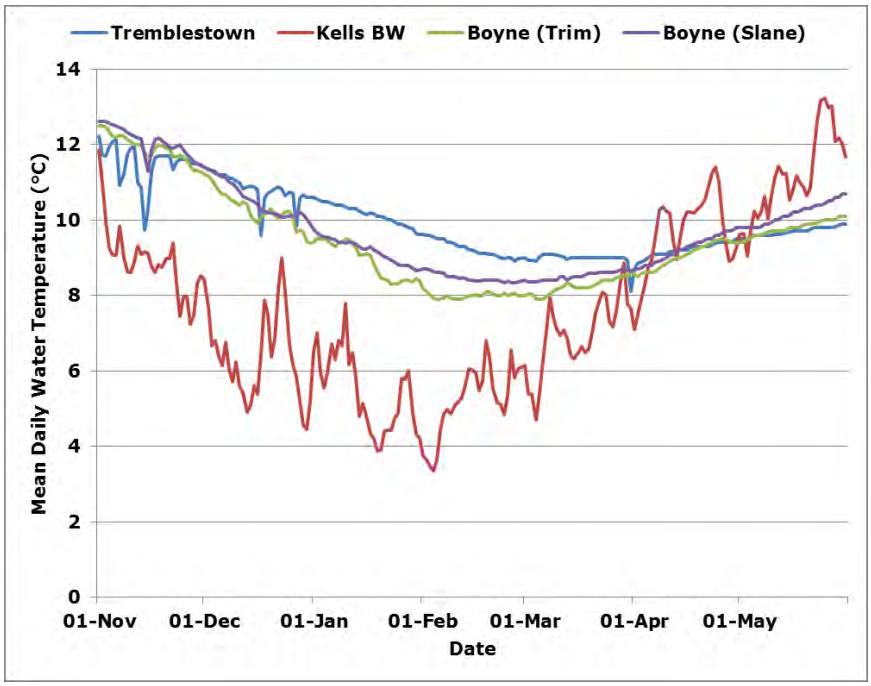


Figure 2.43. Mean daily water levels (a) and temperature (b) (November 2014-May 2015) measured at 4 hydrometric stations throughout the Boyne catchment.

Hydrometric data (water level and temperature, Figures 2.43a and 2.43b) were collected from four OPW monitoring stations on the Tremblestown, Kells Blackwater and main channel Boyne in order to investigate possible correlations between prevailing environmental conditions and river lamprey behavior. No adult river lamprey were captured.

A fyke netting survey was undertaken in April 2015 to complement the trapping exercise and to increase detection range across the River Boyne SAC. The catchment was sampled at 26 locations across the main channel and 10 sub-catchments (Figure 2.44). Sampling was undertaken using

individual fyke nets deployed for two nights. Sites were selected based on their proximity to fast flowing water in gravelled areas, riverine habitat typically associated with spawning activity. Nets were deployed in deeper water downstream of these suitable spawning habitats. Individual sites were sampled once only during April. No river lamprey were encountered in any of the fyke nets, although two brook lamprey were captured in two of the fyke nets on the Kells Blackwater. No evidence of river lamprey spawning was identified in areas examined adjacent to the fyke net locations. Extensive walkover surveys were also undertaken along several sections of the Mattock and Tremblestown rivers. No spawning activity was noted. A carcass was observed in late March in a field alongside the River Boyne by IFI staff immediately downstream of Slane Bridge and weir.

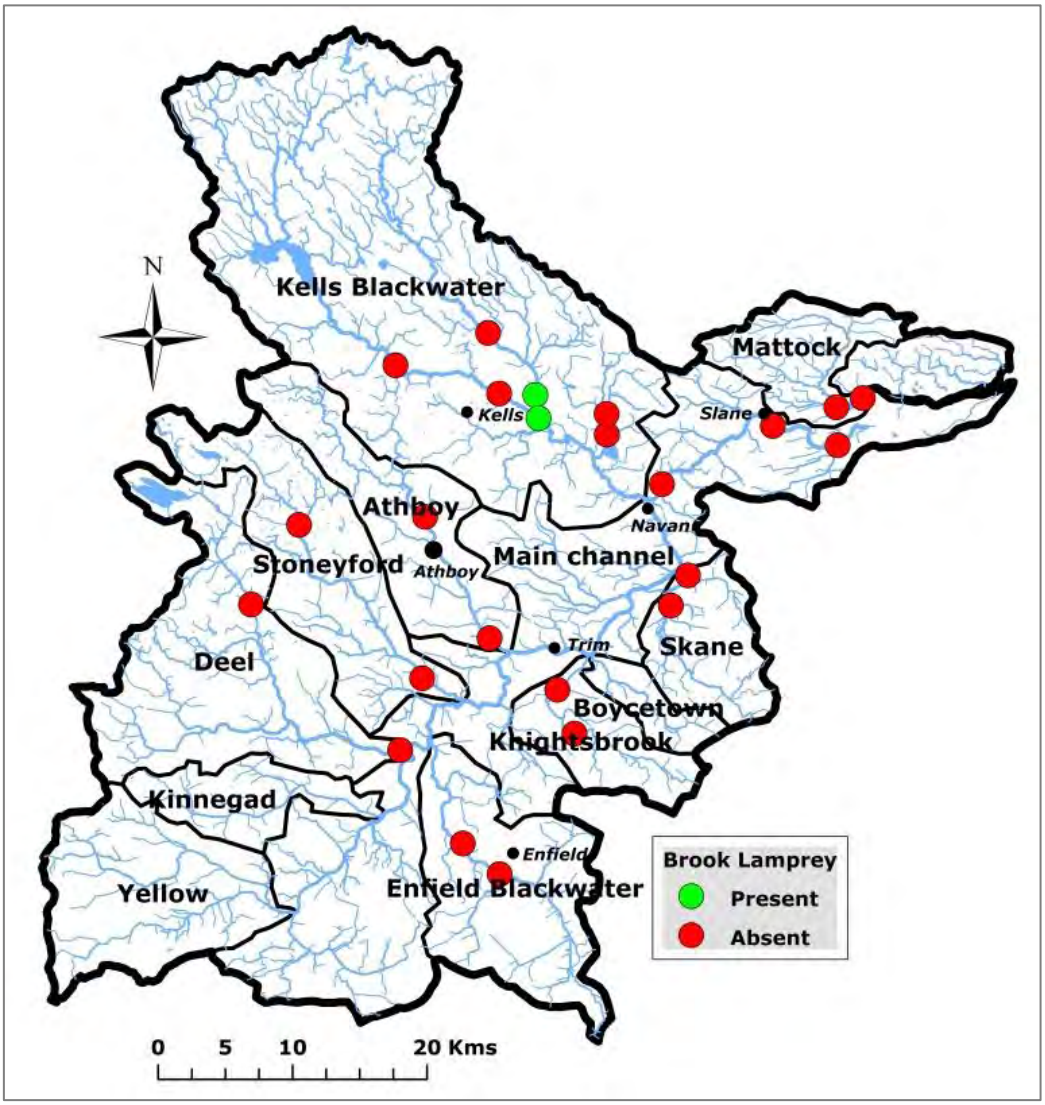


Figure 2.44. Locations of fyke net sampling for river lamprey across the Boyne catchment during April 2015.

Plate 2.16. Setting fyke nets on the Mattock River at Mattock Bridge, Dowth, Co. Meath.

Plate 2.17. Dead river lamprey in field adjacent to River Boyne, Slane, Co. Meath

2.2.5.2 River Slaney Catchment

The River Slaney is a designated SAC for all three lamprey species as well as shad. Historically, river lamprey are known to spawn on the main River Slaney at a site downstream of Aghade Bridge, which is located downstream of Tullow, Co. Carlow. IFI was informed that river lamprey were seen at this location displaying spawning behaviour. The area was visited on 10th April 2015. Both brook and river lamprey were sympatric in the excavation of redds at the site.

Such was the density of fish and distraction of redd excavation, they were easily captured using a landing net. Once caught, the fish were measured, sexed and returned promptly to the river. Due to the proximity to spawning time, secondary sexual characteristics were fully developed. Females may be distinguished from males by a notable thickening of the posterior dorsal fin and also a skirt like membrane adjacent to the cloacal aperture.

In total 32 fish were captured, although the number present was more than this. Fast flowing and deep water hindered the capture of any more fish. There were over three times more females sampled than males. The length of fish varied between 233 and 298 mm (Figure 2.45). There were two modal peaks at 250 and 290 mm.

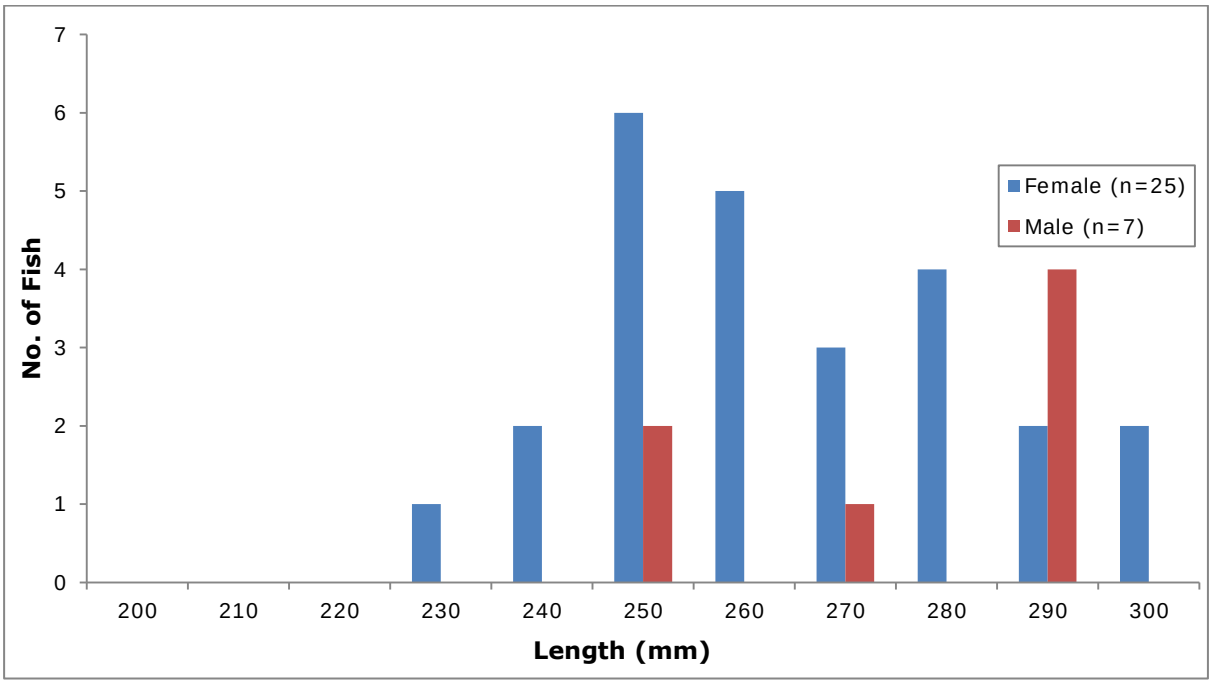


Figure 2.45. length frequency distribution of River lamprey on the River Slaney during April 2015.

Reports of river lamprey spawning on a section of the Boro River, a tributary of the Slaney downstream of Enniscorthy, were investigated on the evening of April 16th. The site in question is immediately downstream of the Soldier's Hole, a natural barrier to upstream migration 2 km from the confluence with the Slaney near Edermine. Spawning was underway at 5 closely spaced centres-of-activity downstream, with between 1 and 12 animals counted on redds. Five individuals were netted, measured and returned to their respective redds. Lengths ranged from 245mm to 289mm (mean=257mm). Corresponding river water temperature was 11.4°C at 19:40pm.
In the future these Slaney sites will be used as 'hot-spots' in order to quantify the scale of river lamprey spawning activity (Figure 2.46).

Plate 2.18. River lamprey spawning grounds on the Boro River, Enniscorthy, Co. Wexford.

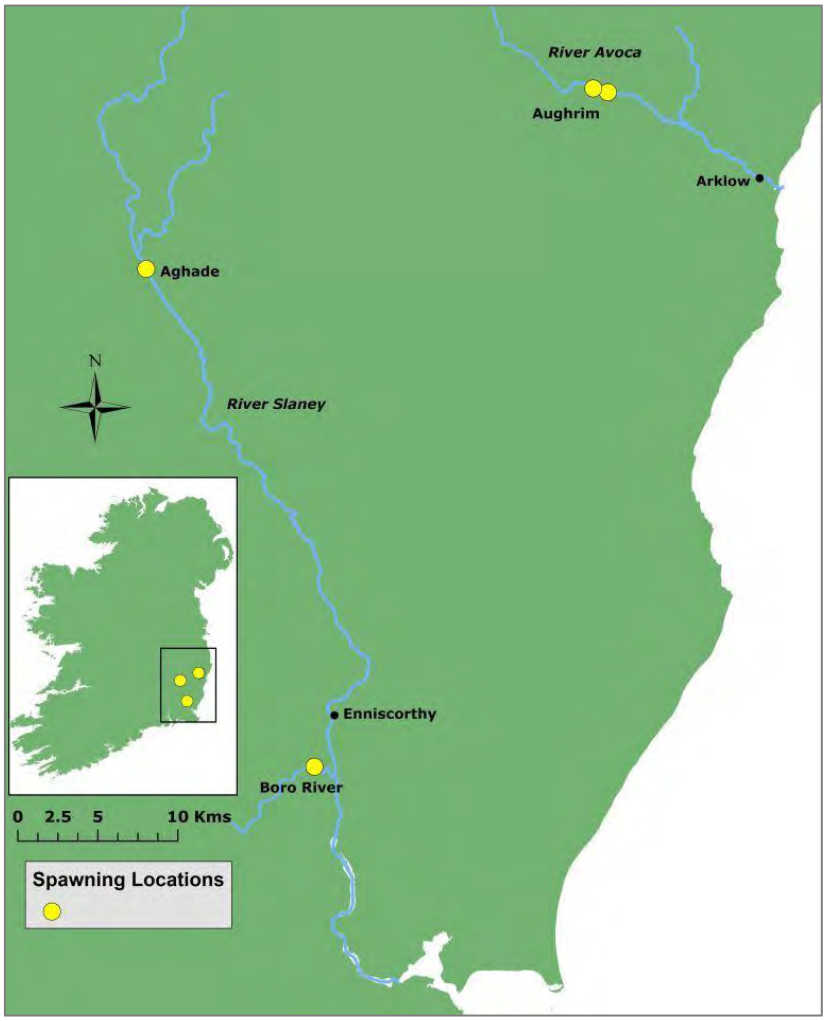


Figure 2.46 Locations of river lamprey spawning observed on the Aughrim, Slaney & Boro Rivers during April 2015.

2.2.5.3 Avoca River Catchment

Records of river lamprey spawning migration and nest building exist for a number of locations on the Aughrim and Avonmore Rivers within the greater Avoca catchment in Co. Wicklow. Several barriers to upstream movement have been identified throughout (Byrne and Beckett, 2012). A visit to the Avoca catchment on April 22nd confirmed river lamprey spawning at 2 locations on the Aughrim River, namely Coate's Bridge and immediately downstream of Aughrim Village. Redd building was extensive at both locations. Two carcasses were retrieved at the former site (body lengths 245mm & 266mm, respectively), whilst two active individuals were observed at the latter location. Corresponding river water temperatures on the day were 11.4°C and 12.0°C at 14:30pm and 15:40pm, respectively.

Plate 2.19. River lamprey spawning redds (circled) on the Aughrim River at Coate's Bridge, Co. Wicklow.

The Avoca catchment was chosen as the focus of trapping efforts for the 2015-2016 winter-spring monitoring period. Traps were deployed during November 2015 at locations on the Aughrim (n=3) and Avonbeg (n=1) rivers. The latter trapping location, 1km downstream of Ballinaclash Bridge, was abandoned in December 2015 due to trap disturbance caused by regular spate conditions, with a more favorable location found on the Avonmore River upstream of Rathdrum. Traps were checked on a weekly basis to the end of December 2015. River lamprey were regularly encountered in one of the traps on the Aughrim River upstream of Woodenbridge (Table 2.5).

Table 2.5. Details of river lamprey captured in traps on the Aughrim River during November and December 2015.

Date of Trap Visit	Number Captured	Length (mm)	Weight (g)
24/11/2015	1	320	n/a
3/12/2015	1	280	40
9/12/2015	2	260 & 325	n/a
16/12/2015	1	310	55
22/12/2015	1	320	65
29/12/2015	0	-	-

Plate 2.20. Deploying a river lamprey trap on the Avonmore River, Rathdrum Co. Wicklow

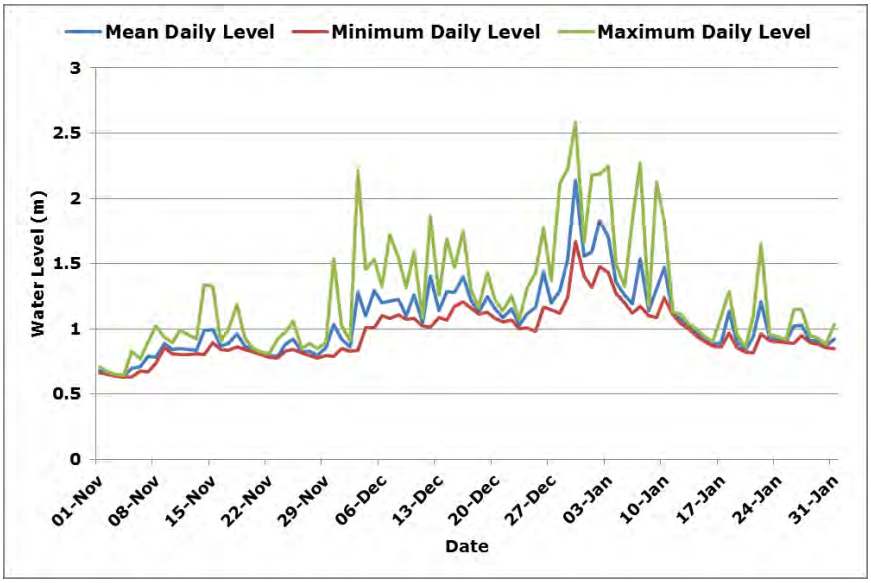


Figure 2.47. River conditions (mean, min. and max. daily levels) on the Aughrim River during the period November 2015 - January 2015 recorded by an EPA hydrometric station immediately upstream of the trapping area at Woodenbridge.

Plate 2.21. A river lamprey captured in late November 2015 on the Aughrim River, Woodenbridge, Co. Wicklow.

3. Shad

3.1 Juvenile Shad Programme

Sampling for juvenile shad was undertaken on the larger southern estuaries during July 2015. The rivers sampled were the Barrow, Nore and Suir. Shad are known to spawn in June and using this information sampling was planned for six to eight weeks post-spawning. This was to ensure that the shad eggs had hatched and the fish had attained a size so as to make the correct species identification possible. Sampling was undertaken between the 20th and 23rd July 2015. In addition to the daytime survey, it was decided to trial a night survey of bongo netting in order to identify if there was any diurnal variation in the catch obtained. The River Barrow was chosen as a pilot project for 2015.

Results

In total 59 trawls were undertaken across 81 kilometres of river (Table 3.1). Juvenile Shad were only present at three locations, one on the River Barrow and two on the River Nore. No Shad were captured on the River Suir.

Table 3.1. The number of trawls performed and sites with shad present, July 2015.

	Distance Sampled (km)	No. of Trawls	Max. length Trawl (m)	Min. length Trawl (m)	Mean length Trawl (m)	No. positive locations
Barrow	32	19 – day	709	166	462	1
		13 - night				0
Nore	13	8	442	183	327	2
Suir	36	19	552	75	316	0

On the River Nore, the sites positive for shad were 1 and 5 kilometres upstream of the confluence with the River Barrow (Figure 3.1). The positive site for juvenile shad on the River Barrow was 10 km upstream of confluence with River Nore.

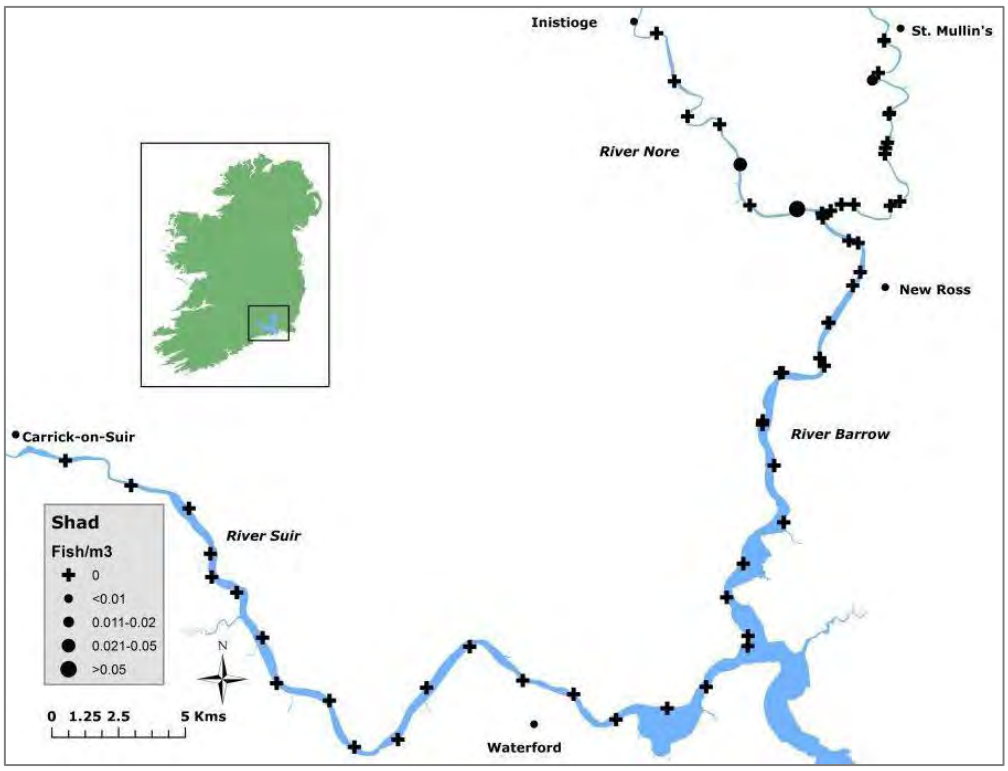


Figure 3.1. Distribution of juvenile shad on the Rivers Barrow, Nore and Suir during July 2015.

In total 8 fish were captured on the River Nore and one on the River Barrow (Figure 3.2). The length of fish varied between 17 and 28 millimetres.

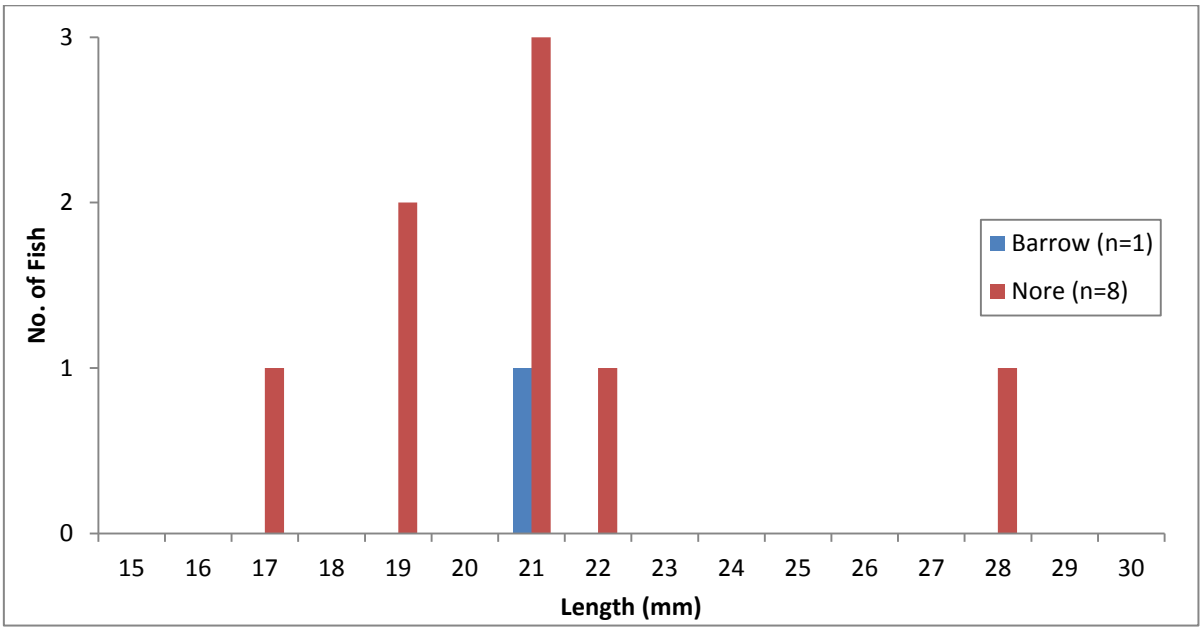


Figure 3.2. Length frequency of juvenile shad on the Rivers Barrow, Nore and Suir, July 2015.

Other species captured during the bongo netting included European seabass, , goby, herring, mullet, sprat and three spined stickleback. Large numbers of mysid shrimp were captured during the night survey of the River Barrow but no juvenile shad were recorded.

Review of Bongo netting programme 2010 - 2015

The four SAC rivers of the Slaney, Barrow-Nore, Suir and Blackwater were surveyed for juvenile Twaite shad over the six year period from 2010 – 2015 (Figure 3.2). There is limited knowledge on the early life stages of this species in Ireland and it was hoped that the survey programme would provide information on post larval distribution patterns, densities and growth rates. From its explorative beginnings in 2010, the sampling methodology was adjusted and refined over subsequent years.

Table 3.2. Number of shad recorded during the survey period 2010 – 2015.

Year	Month	River	Trawls	Positive Trawls	No. Shad
2010	June	Barrow	11	0	0
	July	Suir	8	0	0
	August	Barrow	13	0	0
		Nore	7	0	0
2011	June	Barrow	9	4	103
	July	Barrow	18	12	72
		Nore	10	2	3
		Suir	8	0	0
2012	July	Barrow	15	0	0
		Nore	8	0	0
		Suir	17	0	0
2013	July	Barrow	17	4	30
		Nore	8	3	14
		Suir	18	1	1
	August	Barrow	16	5	8
		Nore	7	0	0
		Suir	14	1	1
2014	July	Barrow	11	1	2
		Nore	3	0	0
		Suir	27	1	3
2015	**July**	Barrow	34	1	1
		Nore	8	2	8
		Suir	19	0	0

Shad were recorded in four of the six years, with no specimens captured during 2010 and 2012. Overall numbers tended to be low with the highest numbers of individuals recorded from the River Barrow during the June and July surveys of 2011. Using water temperature data and hydrometric data from OPW gauging stations on the Rivers Nore and Barrow, an attempt was made to detect a

pattern in the shad records and to examine the efficacy of the sampling procedure. While it may be possible to identify flood events in 2010 and 2012 as having negatively impacted on shad recruitment, it is difficult to establish an underlying cause for the low numbers of shad caught in 2013 – 2015. Given that river conditions were generally stable in those years, the absence of shad records may reflect poor timing of surveys, an inadequacy in sampling technique or some underlying cause such as limited spawning success.

While shad have been recorded in these surveys the data is inadequate to provide information on shad recruitment success and early life stages at this point in time. Monitoring of juvenile shad is challenging given the uncertainty of the timing of spawning, the small size of the fish as well as environmental factors such as flood events and tidal influences. The Barrow-Nore system returned the highest numbers of shad over the survey period and it may be appropriate to focus on these rivers in future monitoring. No shad were recorded during the night survey of the River Barrow in 2015 indicating that diel migration may not be a factor in capturing juveniles. The focus of future monitoring will be to establish an optimum sampling method with an emphasis on the timing of sampling, flood events, water temperature and tidal regime.

3.2 Waterford Harbour Trawling Survey

A trawling survey, similar to that undertaken in 2014, was conducted in Waterford Harbour over five days in 2015 (August 31st to September 4th) to provide data for IFI's National Bass Programme. As before, trawling was conducted by a commercial trawler and crew (Plate `3.1) with 2-3 IFI staff also on board to process catches. Thirty-six trawled transects, typically 10-15 minutes in duration, were undertaken across the lower Suir estuary (Kings's Channel, Belview and Cheekpoint), the lower Barrow estuary (Fisherstown, Great Island and Kilmokea) as well as locations throughout Waterford Harbour (Passage East, Duncannon and Woodstown). Overall, 35 species of fish were encountered, an identical number to 2014. Twaite shad and smelt were obtained along a number of the transects (Figure 3.3 & 5.4). No lamprey were recorded on this occasion.

Plate 3.1. Trawling survey along a transect in Waterford Harbour.

Shad (n=3) were encountered in three trawls (Figure 3.3) with single individuals captured in King's Channel, at Cheekpoint and in the outer Harbour at Duncannon (Plate 3.2). Shad ranged in length from 215mm to 320mm (Figure 3.4). Fewer shad were recorded in 2015 when compared with 2014 survey results (3 vs. 26).

Plate 3.2. A shad captured during trawling near Cheekpoint, Co. Waterford.

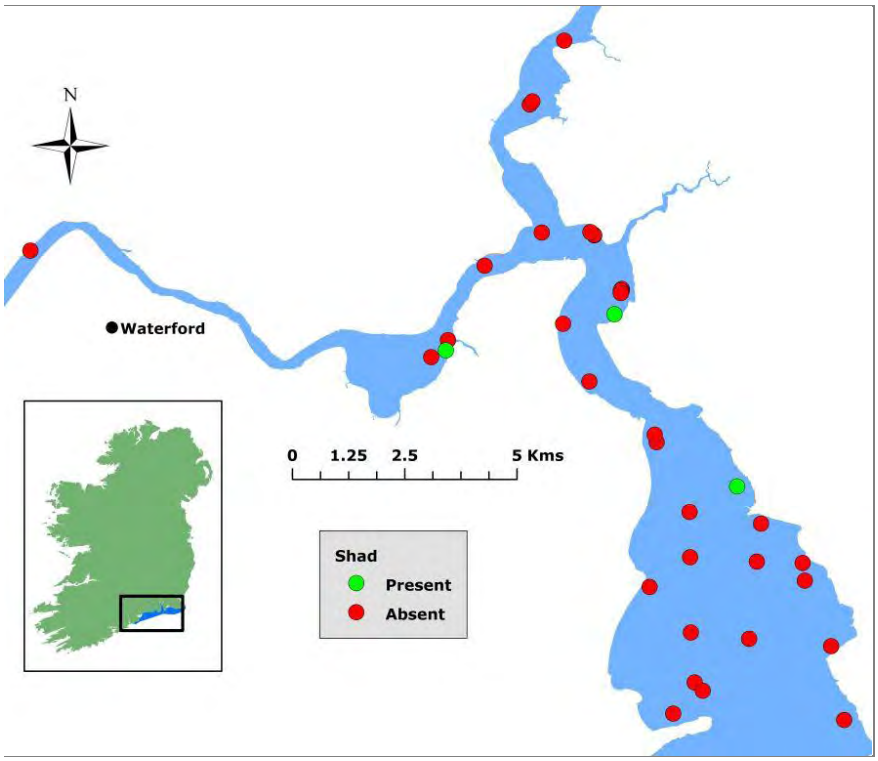


Figure 3.3. Location of survey trawls throughout Waterford Harbour and associated incidence of shad capture.

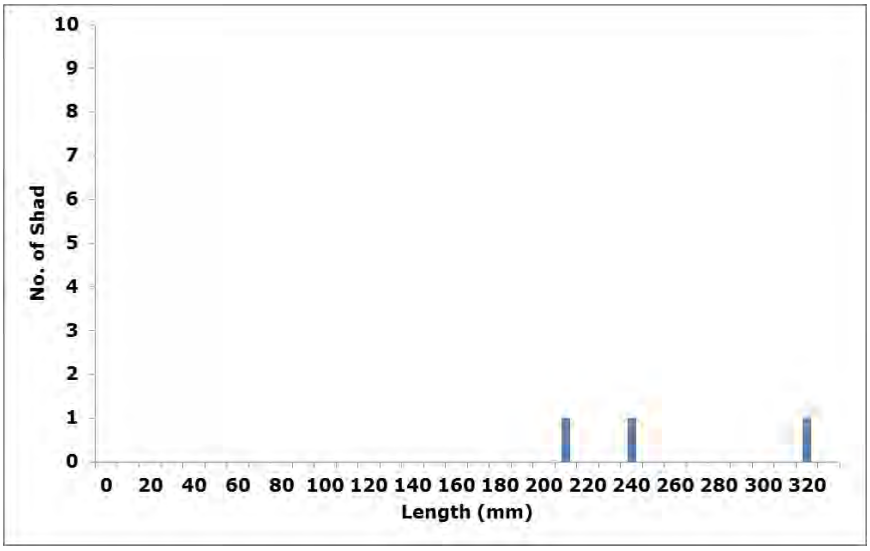


Figure 3.4. Length frequency distribution of shad (n=3) captured during trawls on Waterford Harbour.

3.3 Anadromous Shad Investigations

3.3.1 Telemetry studies

During 2015, anglers at St. Mullin's captured specimen sized (>1200g) Twaite shad from April 29th to May 30th. Anglers reported excellent catches over this period in comparison with previous years, with a new record specimen weighing 1640g captured on May 15th. The annual angling competition was held on Sunday May 3rd between 2pm and 6pm. Water temperatures on the day were 11.2 °C, however heavy overnight rain resulted in raised river levels and coloration during the competition and as a consequence fishing was poor.

Plate 3.3. A large Twaite shad captured in Waterford Harbour.

The acoustic telemetry study on the Barrow-Nore, initiated in 2012, was continued during 2015. Priorities during this season were to extend acoustic receiver coverage throughout the tidal section

of the Suir, and also to catch and tag fish earlier and closer to sea. Unfavourable weather conditions hampered plans to set nets in outer Waterford Harbour throughout late winter and early spring. Netting was possible in early April and a large female Twaite shad (2000g, 49cm) was captured at Booley Bay. This fish was tagged (#26207) and released. Two further netting exercises on the Barrow upstream of New Ross yielded 8 more Twaite shad for tagging (Table 3.3).

Table 3.3. Details of acoustic tagged Twaite shad during 2015.

Date	Location	Sex	Length (cm)	Weight (g)	Tag ID
09/04/2015	Booley Bay, Duncannon	F	49	2000	26207
14/05/2015	Barrow, d/s St Mullin's Quay	F	46	1250	26189
14/05/2015	Barrow, d/s St Mullin's Quay	M	40	900	26194
14/05/2015	Barrow, d/s St Mullin's Quay	F	44	1100	26203
14/05/2015	Barrow, d/s St Mullin's Quay	F	48	1150	26208
14/05/2015	Barrow, d/s St Mullin's Quay	F	46	1750	259
20/05/2015	Barrow, d/s Nore confluence	F	40	890	260
20/05/2015	Barrow, d/s Nore confluence	F	41.5	1000	261
20/05/2015	Barrow, d/s Nore confluence	M	39.5	1050	263

A total of 19 acoustic receivers were deployed throughout the study area during 2015, including 3 on the Suir (Carrick-on-Suir, Fiddown & Waterford City), 2 on the Nore (Inistioge & Rathsnagadan), 13 on the Barrow (10 upriver from New Ross to St Mullins, 3 downriver from New Ross to Barrow Bridge/Kilmokea) and 1 in outer Waterford Harbour at Passage East. In addition 2 receivers were deployed on the Munster Blackwater in Youghal Harbour and at Cappoquin to detect any possible stray fish movements into this adjacent spawning river (Figure 3.5).

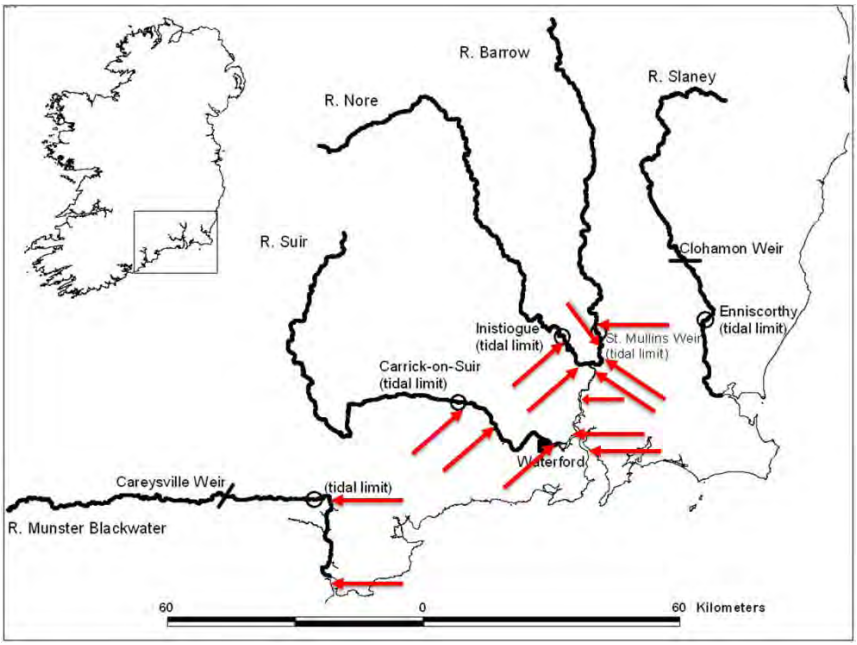


Figure 3.5. Locations of acoustic receivers to monitor movements of Twaite shad.

Spawning activity of tagged fish appeared in the River Barrow exclusively, with a number of individuals continuously present in St Mullin's during periods in late May and again during mid-June, coinciding with rises in water temperature in excess of 15°C (Figure 3.6). Two of these tagged fish were also detected in the lower River Suir at Waterford City on a number of occasions

during April and May, however none were detected in the River Suir at receiver locations upstream of this point. No activity was recorded in the River Nore nor in the Munster Blackwater. The final detection of a tagged shad was made on June 19th at Passage East.

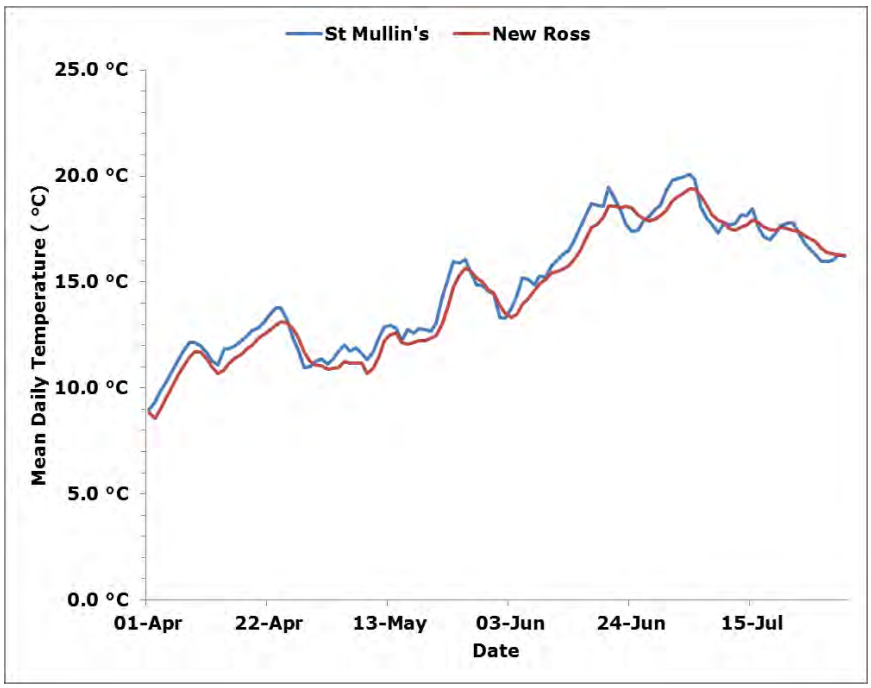


Figure 3.6. Water temperatures (April - July 2015) recorded at St Mullin's and New Ross.

Plate 3.4. A tagged Twaite shad prior to release.

3.3.2 Marine-caught shads

IFI has developed an informal network of sharing information on by-catch of marine-caught shad with the Marine Institute, Bord Iascaigh Mhara (BIM) and the Sea Fisheries Protection Authority (SFPA). In addition, the occasional marine-caught material becoming available to IFI officers within the River Basin Districts is made available to the Habitats Directive team.

In 2015, a small sample of 17 fish was available, consisting of 9 Allis shad from BIM staff, 1 Allis shad from Marine Institute and 7 Twaite shad submitted through the Fisheries Inspector for the Lismore Fisheries District. The fish were speciated based on gill raker counts.

The BIM material all came from a survey programme of that organization off the south west coast, using local commercial fishermen in bottom gill netting operations for target species. The sample contained 7 female fish and 2 male fish. All of these had high gill raker counts (Figure 3.7) and a low gonadosomatic index of < 1.5%, the low degree of gonad development being typical for autumn-caught fish.

The lone Allis shad from the Marine Institute came from a trawling operation 200 km west of Achill. This fish was taken in August and also had a low gonadosomatic index.

All of the Twaite shad material came from Youghal Bay at the mouth of the Munster Blackwater. This area also produced one Allis shad. All of this material dated from February-March 2015. Twaite shad are known from the Blackwater and have been recorded in angling surveys in May on presumed-spawning areas upriver of Cappoquin as well as in commercial netting in the middle estuary round Villierstown. The spring-caught 2015 (February – March) fish all displayed a degree of gonad development. This might be expected, given the spawning period for the species as May-June in any year. The single male fish had particularly developed gonad, with a gonado-somatic index value of 8%. The information available supports the idea of a resident population of shads in the marine – estuarine habitat around the Munster Blackwater area. The fish taken in Youghal Bay may be part of a population that uses the estuary as a spawning migration route and adjacent marine area as a feeding and foraging habitat.

While small in number, the samples in 2015 all contribute to the building up of a story and filling gaps in shad life history – do the Twaite shad remain adjacent to estuarine waters? What is the origin of the Allis shad taken around the Irish coast? What is the range of Allis shad around the Irish coast?

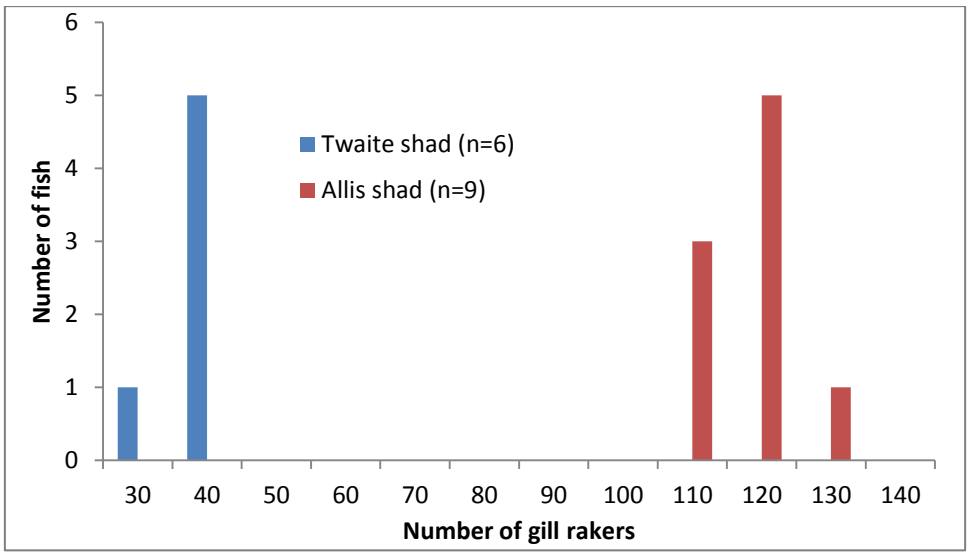


Figure 3.7. Gill raker counts from marine-caught shad presented in 2015.

4. Pollan Programme

4.1 Pelagic Netting Lough Allen

Introduction

Pollan are protected as an Annex V species of the Habitats Directive (92/43/EEC). Under the Irish implementing legislation for Habitats Directive, the Minister for Communications, Energy and natural Resources is tasked with surveillance of the status of those fish species listed in the Directive that occur in Ireland. Inland Fisheries Ireland undertakes this task for the Minister. Populations of pollan are known in Loughs Allen, Ree and Derg within the Republic of Ireland. Pollan are also present in two lakes in Northern Ireland, Lough Neagh and Lower Lough Erne (Figure 4.1). Previous investigations by IFI have used Pelagic netting as a sampling device for this species. During 2015 a study was undertaken on Lough Allen to investigate any seasonal changes within the pollan population structure. Questions posed prior to the survey were – would there be a difference in the size range of fish caught at different times of the year? At what pelagic depth would the fish be captured? What was the gravid state across a temporal timeframe?

Figure 4.1. Map outlining locations of pollan lakes in Ireland.

Materials and Methods

Using information previously collected by IFI, net locations were based on areas of the lake where these studies had gained positive results (Figure 4.2). The deepest section of Lough Allen lies in the northern part and deeper waters are known to be the preferred habitat of pollan.

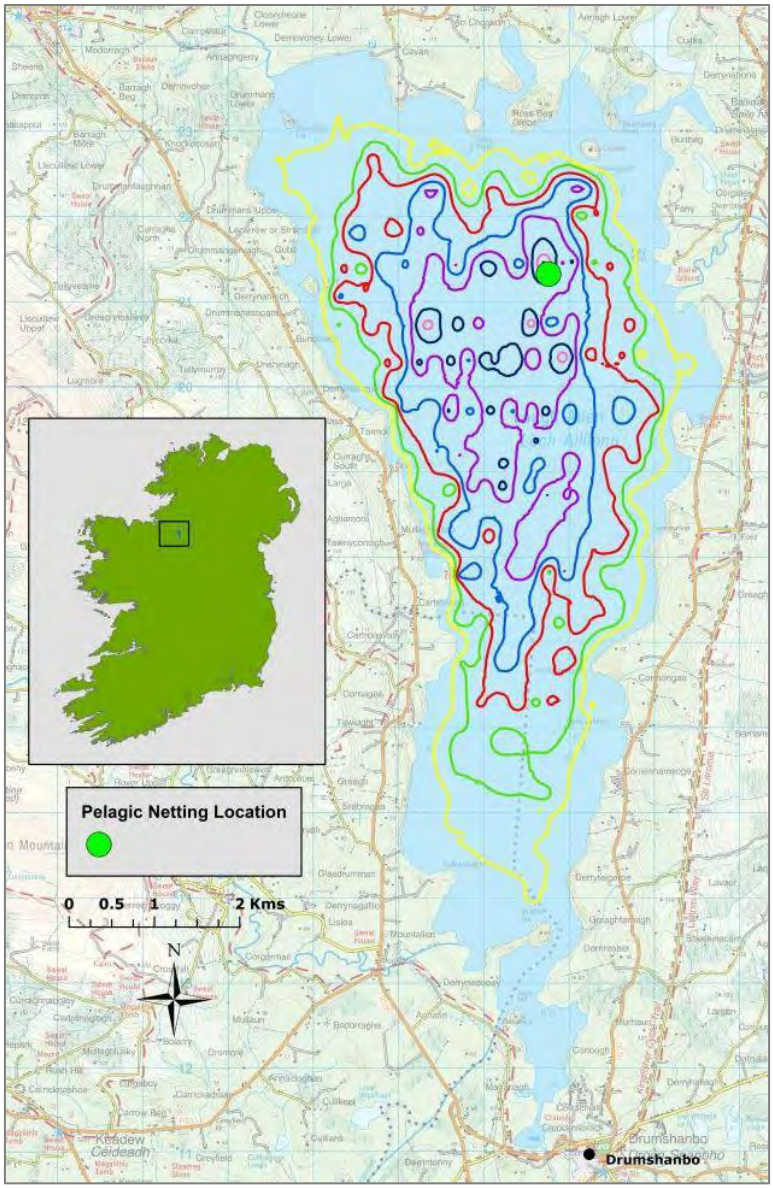


Figure 4.2. Depth contour map outlining locations of pelagic nets on Lough Allen.

Pelagic monofilament multi-mesh (30 meter x 6 meter, 12 panel, 5-55mm mesh size) CEN standard survey gill nets were used for the survey. The net locations were uploaded to a handheld GPS (Global Positioning System). This GPS was used on site to determine where the nets were to be deployed. The lake depth was measured at the beginning and end of each net in order to position them in the correct depth zone. Nets were generally deployed in an east to west direction and left to sample overnight. The nets were set to fish at specific depths in the water column i.e. they were sampling pelagically. During the June and September sampling season six nets were deployed at different depth zones to monitor the whole pelagic zone of the lake (Table 4.1). During the February 2016 sampling event it was decided to only deploy two nets at the surface of the lake.

Table 4.1. Number and depth zones of pelagic nets across a temporal variation.

Depth (m)	June 2015	September 2015	February 2016
0-5.9	1	1	2
6-11.9	1	1	
12-17.9	1	1	
18-23.9	1	1	
24-29.9	1	1	
30-35.9	1	1	
Total	**6**	**6**	**2**

The nets were deployed in June (2015), September (2015) and February (2016). This was to identify any seasonal changes within the population structure and gravid state of the fish. It was hoped to complete the sampling within the 2015 sampling year, but due to adverse weather and a number of storms during November and December, the final sampling was undertaken in February.

As the nets were retrieved, any fish which were alive were measured, scales collected for ageing and the fish were released. The remaining fish were removed from the nets and the fish from each net retained in a labelled bag, individual to each net. These fish were frozen until such time that they were dissected. During the dissection process the species, length, weight, scales, sex, maturity and stomach contents of all fish captured were collected.

Results

Pollan were captured on all three sampling occasions. Pollan was the dominant species during the survey, followed by perch and brown trout. In June, when a full complement of nets was deployed, the majority of the fish were captured in the 0-5.9 meter depth zone. The September sampling showed the pollan to be more widely distributed among the depth zones, with a large portion present in the uppermost three depth zones fished (Figure 4.3). Given the number of fish captured during the June and September sampling and the prevalence of pollan in the upper layers of the water column, it was decided to only sample this depth zone during the February survey (Figure 4.3).

Of the 14 nets deployed over the course of the survey only one net did not capture pollan, the 12-17.9 meter net deployed in June.

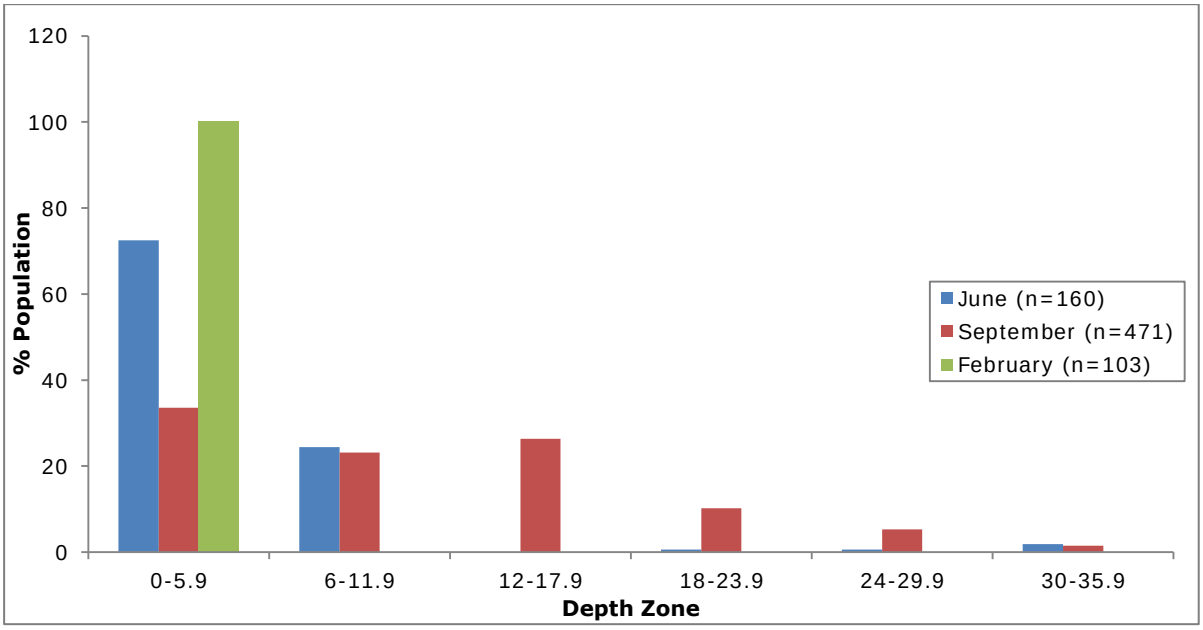


Figure 4.3. Percentage of catch captured at different depth zones across a temporal variation on Lough Allen. (Note: Only 2 x 0-6 meter nets were deployed during the February sampling)

Plate 4.1. Lough Allen, February 2016.

The length of pollan varied between 38 and 168 millimetres (Figure 4.4). Three size classes were recorded over the sampling period (Figure 4.4). During the June sampling, the majority of the fish were in the 40 – 60 mm size class. These fish were generally captured in the two nets deployed in the water column above 12 meters. During sampling in September, the net deployed at 0-6 meters yielded the greatest number of fish, the majority of which were less than 100 millimetres. The net deployed at 12-18 meters was also successful with both the 80-90 milometer fish and the 130-140 milometer fish represented. On both September and February sampling occasions the same two size groups were observed, with the majority of the fish captured in the 80 – 90 mm size range.

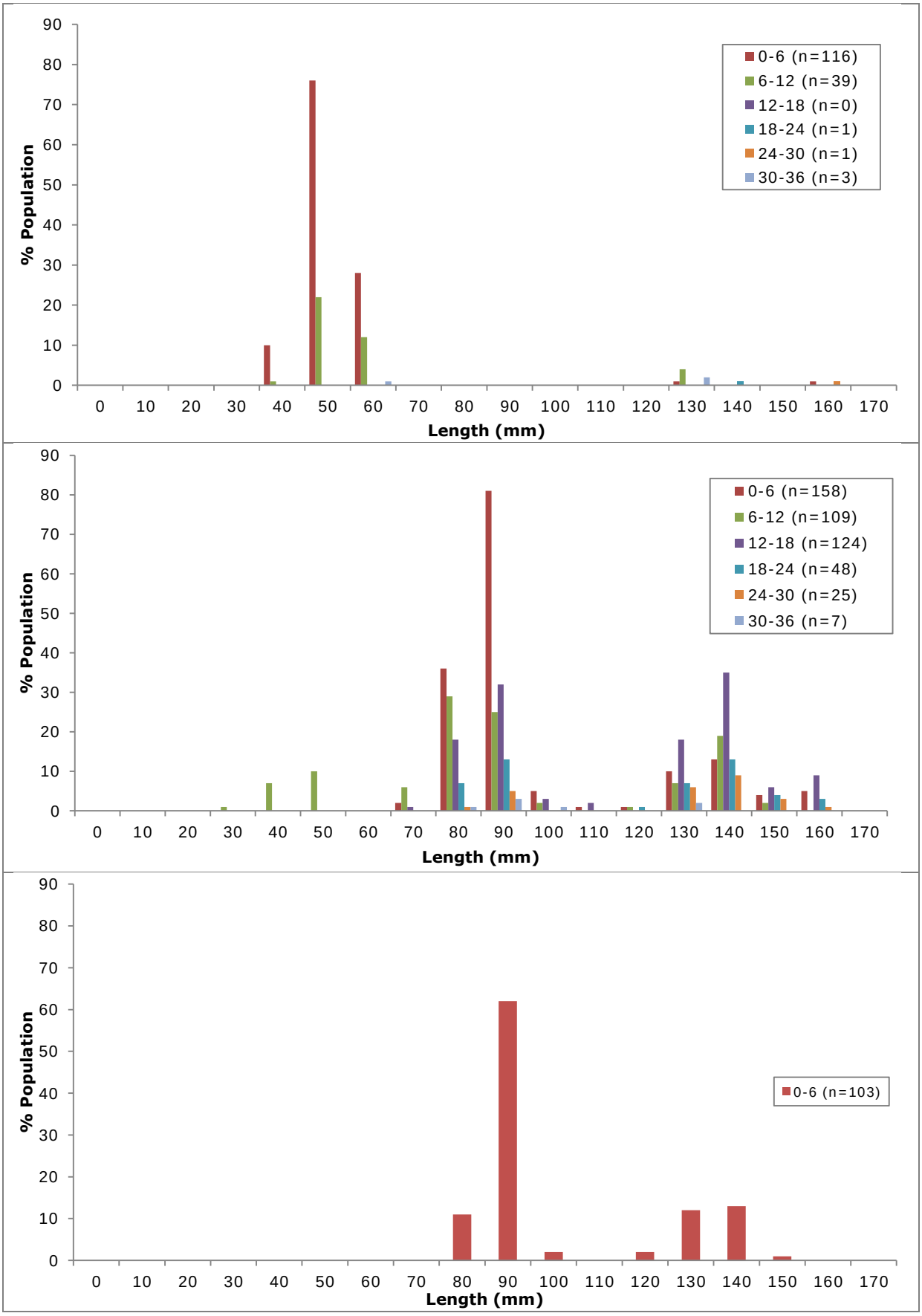


Figure 4.4. Percentage Length frequency of pollan caught across a depth profile and seasonal variation (June, September and February) on Lough Allen.

The length versus weight was compared for pollan across the three sampling seasons (Figure 4.5). Length to weight comparisons were similar in the 40 to 60 millimetres and 80 to 100 millimetres size ranges across all sampling occasions. However, when sampled in February, fish in the 130 to 160 mm size range were lighter than those from the two previous sampling occasions. This may be a reflection of loss of 'condition' following spawning and dissection of fish in February indicated that many of the males and females had recently spawned.

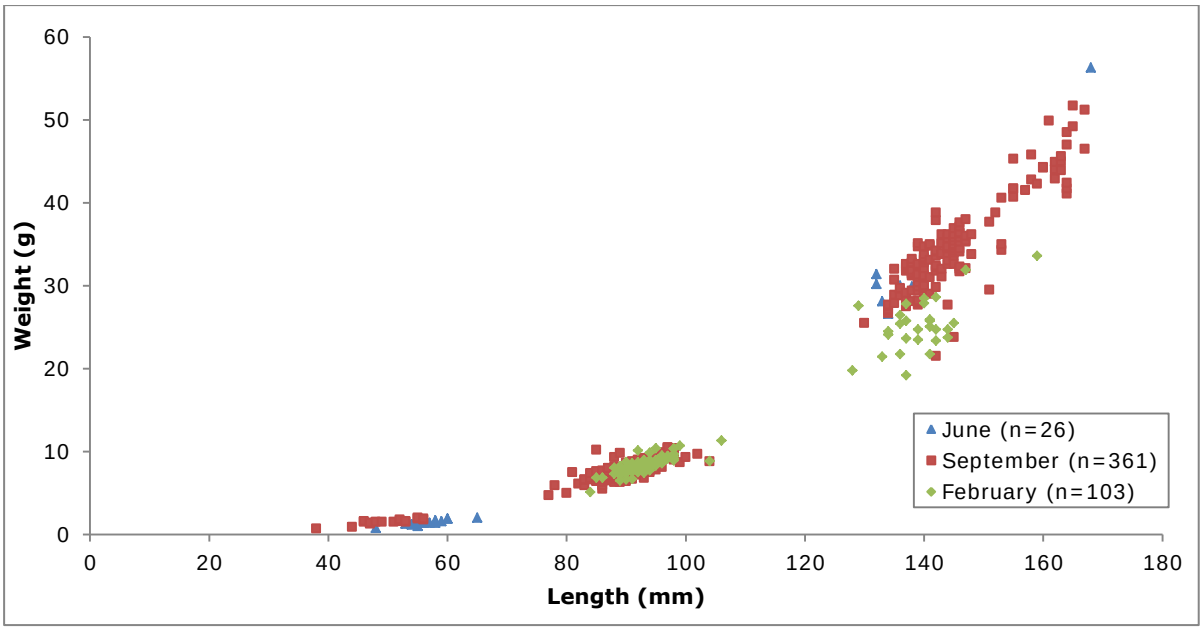


Figure 4.5. Length versus weight of pollan caught across a seasonal variation on Lough Allen.

When sampling in June, the fish were very fragile and many separated. This made the identification of stomach contents difficult. However, those that could be identified contained zooplankton in the form of copepods. This made up the bulk of the diet. Adult dipterans and chironomid larvae were also recorded in the stomach contents. The pollan captured during the September sampling had similar stomach contents to those in June. The stomach contents of the fish sampled during February comprised of zooplankton in the form of copepods. During June and September, there was no defined variation in the stomach contents across the different depth zones sampled.

Information from dissected fish revealed the presence of a population comprising of more males than females on the three sampling occasions (Table 4.2). The largest population was obtained during the September sampling which displayed the least variation in the male to female ratio.

During June, the fish which were 132 millimetres or smaller were all immature. All fish captured above this size displayed evidence of gonadal development. Dissection analysis of fish sampled during September revealed gonadal development in a female and male at 130 and 134 millimetres respectively. However, a fish measuring 146 millimetres displayed no evidence of sexual development and the sex could not be identified. Analysis of the fish captured during February were interesting, in that from a number of similar sized females (141milimters), two fish were spent and another was in the very early stages of gonadal development. In relation to males, a 95

millimetre individual displayed early sexual advancement. Another male at 128 millimetres was spent. Of the 103 fish captured in February, 74 were immature, the largest measuring 159 millimetres. In total 4 spent females (141-144 millimetres) and 12 spent males (128 to 142 millimetres) were present in the sample from February.

Table 4.2. Ratio of males to females in pollan from Lough Allen.

	Lough Allen Pollan		
	Male	**Female**	**n**
June	0.75	0.25	8
September	0.52	0.48	161
February	0.85	0.15	52

Discussion

The seasonal survey of Lough Allen gave an insight into pollan population structure on Lough Allen. The majority of the fish were caught on the 0-6 meter depth zone. The majority of food consisted of zooplankton, which can migrate up and down in the water column, with the pollan following the movement of the zooplankters. The smallest fish were the 40-60 mm fish captured during the June sampling (Figure 4.4). The September modal peak of 90 mm was considered to represent growth of the June 40 − 60 mm size class.

A second size class, 130-160 mm, was also identified during the September sampling and represented approximately 30% of the sample size. This range was largely absent from the June sampling but was present in February, consisting of 25% of that sample. During the September sampling only 12% of fish in this size range were present in the surface nets. Further investigations would be necessary in order to explain the absence of this size range in June.

The length versus weight comparison revealed lighter fish in February than those in the previous sampling occasions for the larger fish (140 to 180 millimetres). Prior to this there was little variation in the length as a function of weight, nor was it visible in the smaller fish. This was due to spent fish captured in February. Pollan are thought to spawn during mid to late December. Based on the weight of the fish and the gonadal condition, it was observed that the pollan had spawned in the February sample. This would indicate ongoing population regeneration of pollan on Lough Allen.

When the gonadal development was investigated, there was a disparity between the length of fish and the sexual development. Evidence of maturation was displayed in small fish and on occasion absent from larger fish, which would have been expected to have been of a reproductive age, given their size. Of the fish captured during February, 72% were immature. Given that pollan spawn during the winter months, it would have been expected that more fish were either mature adults or spent following the sampling in February, especially those in the larger size class. The fact that one of the largest fish (159 millimetres) captured across all season was immature in February poses more questions into the reproductive physiology of pollan.

Article 17 of the Habitats Directive requires the estimate of population size, along with the population structure and species distribution of pollan for the EU. The shift in the modal length of

fish caught between sampling occasions and the presence of spent fish indicated natural population dynamics within the species. The numbers of fish caught during the sampling occasions indicated a large sample of pollan within the lake. These studies complement hydroacoustic investigations being undertaken by IFI on the Shannon lakes for pollan.

It is hoped to continue the pollan seasonal pelagic netting survey in 2016. It is proposed to utilise a similar technique to sample the pollan population of Lough Ree and continue in 2017 by sampling Lough Derg.

5. Smelt Programme

5.1 Juvenile Smelt Programme

Introduction

Sampling for juvenile smelt was undertaken on the larger southern estuaries during July 2015. The rivers sampled were the Barrow, Nore and Suir. Smelt are known to spawn in March or April, thus by the time sampling was undertaken, the fish were approximately three months post spawning.

Materials and methods

Sampling was undertaken using bongo nets, from downstream of known spawning areas to the lower reaches of the estuary (Plate 5.1). The net was suspended from the bow of the boat, and the two nets fished either side of the boat. The sampling was against the tide along a depositing bank. This slacker water provides shelter for juvenile fish with limited swimming abilities at such a fragile phase in their lifecycle. At the commencement a GPS location reference was recorded. Each trawl was 10 minutes in length. In order to sample each river using the same effort, trawls were located 2 kilometres apart. Another GPS reference was recorded at the end of the trawl, at which time the contents of each bongo net were sieved and, where fish were present, retained in 70% alcohol for preservation and later identification. Using ArcView10 and the GPS reference points the length of each trawl was calculated. Using the length of each trawl, the volume of water sampled was determined:

Volume Filtered (VF) = $[(\pi * D^2)/4] * L$

- L is distance travelled
- D net diameter

The density of fish was then calculated as:

Number Smelt/meter^3 = No. Smelt/VF

- After Navodaru (2001)

It was decided to trial a night survey of bongo netting in 2015 in order to identify if there was any diurnal variation in the catch obtained. The River Barrow was the chosen river for this pilot project.. The sampling programme for 2016 may be decided on whether day or night provides the greatest yield of target species.

Plate 5.1. Bongo net used to undertake juvenile fish surveys.

Results

In total 59 trawls were undertaken across 81 kilometres of river (Table 5.1). All rivers sampled presented with populations of juvenile smelt.

Table 5.1. The number of trawls performed and sites with smelt present, July 2015.

	Distance Sampled (km)	No. of Trawls	Max. length Trawl (m)	Min. length Trawl (m)	Mean length Trawl (m)	Max. no. fish/ m^3	Mean no. fish/ m^3	No. positive locations
Barrow	32	19 – day	709	166	462	0.046	0.008	5
		13 - night				0.105	0.023	8
Nore	13	8	442	183	327	0.023	0.007	3
Suir	36	19	552	75	316	1.424	0.259	10

The first occurrence of smelt on the River Suir was 3 kilometres downstream of Carrick-on-Shannon (Figure 5.1). On the River Nore, smelt were encountered 7 kilometres downstream of Inistioge. On the River Barrow, the first instance of smelt was 9 kilometres downstream of St. Mullins.

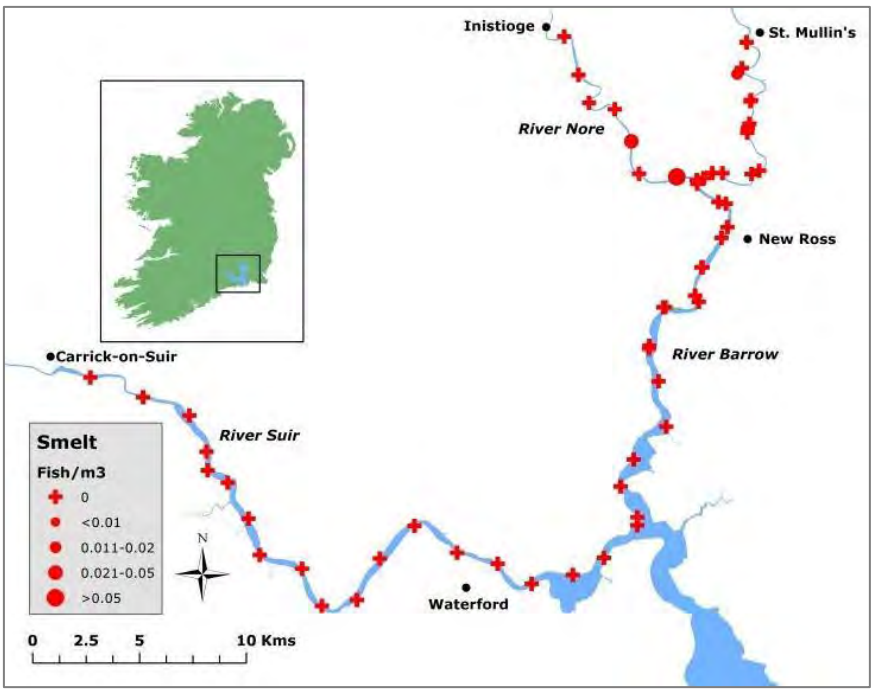


Figure 5.1. Distribution of juvenile smelt on the Rivers Barrow, Nore and Suir during July 2015.

The length of smelt varied between 25 (River Suir) and 49 (River Barrow) millimetres (Figure 5.2). The majority of the fish were captured in the River Suir. The fish present on the River Suir were smaller than those on the other two rivers. This could indicate that the smelt on the River Suir spawned later than those on the Rivers Barrow and Nore. This could also be indicated by the fact that there were no smelt distributed downstream of Waterford city. The night survey on the River Barrow yielded almost 2.5 times the number of fish captured during the day survey, despite there only being a day between sampling events.

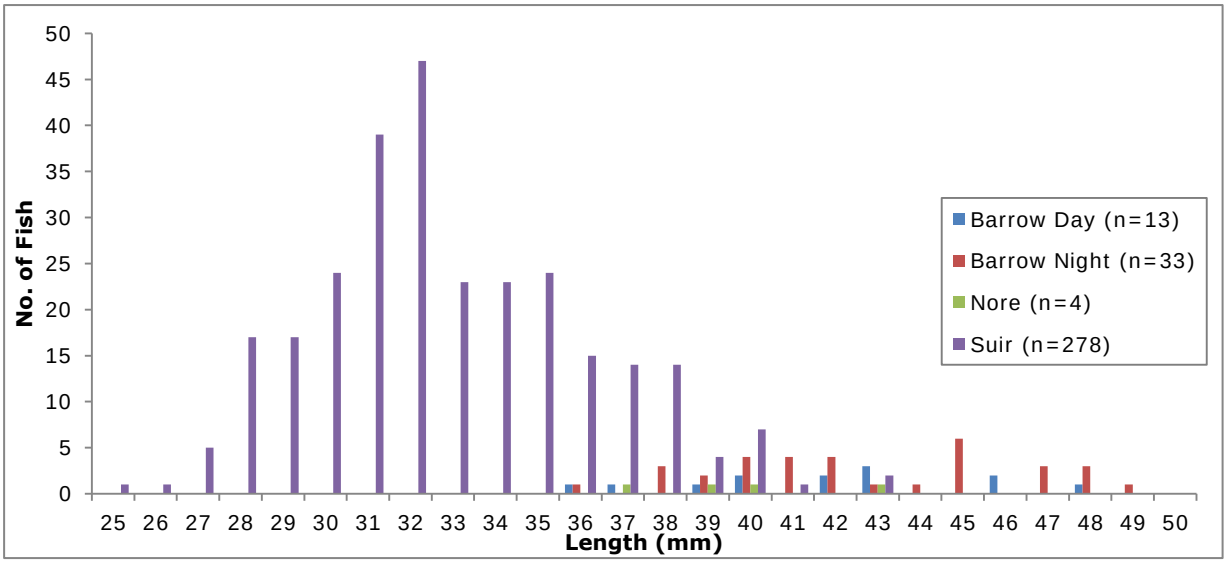


Figure 5.2. Length frequency of juvenile smelt on the Rivers Barrow, Nore and Suir, July 2015.

Discussion

The River Suir produced great numbers of juvenile smelt during the 2015 survey. In one sample alone 91 individual smelt were captured. The wide variation of lengths of smelt on the River Suir could indicate that there were a number of spawning events. The proximity of the fish to Carrick-on-Suir, which is the tidal limit of the river, and assumed to be the spawning area, could denote that the fish spawned later than those on the Rivers Barrow and Nore. It would be assumed that in July, a fish born in March/April would have migrated further downstream than 3 kilometres below Carrick-on-Suir.

Although there was a greater number of fish captured on the River Barrow night survey than during the day, there was not much of a difference in the length frequency of the fish. All size classes were represented in both samples.

5.2 Waterford Harbour Trawling Survey

Smelt (n=157) were present in 16 survey trawls (Section 3.2) covering the lower Suir at Waterford City, King's Channel, Belview Port and Cheekpoint, the lower Barrow at Fisherstown and Waterford Harbour from Great Island through to Passage East and Duncannon (Figure 5.3). A subsample of the smelt captured (n=75) were retained for dissection and further detailed analysis. Smelt in this subsample ranged in length from 66mm to 257mm. (Figure 5.4). An identical survey in 2014 captured 186 smelt in total.

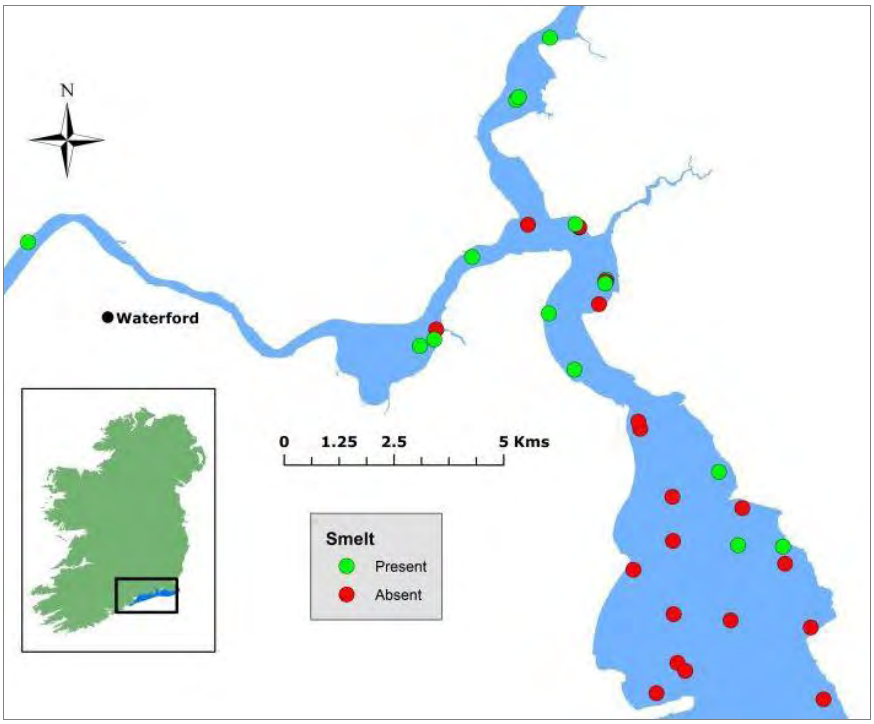


Figure 5.3. Location of survey trawls in Waterford Harbour and incidence of smelt capture.

Plate 5.2. Contents of a survey trawl from Waterford Harbour.

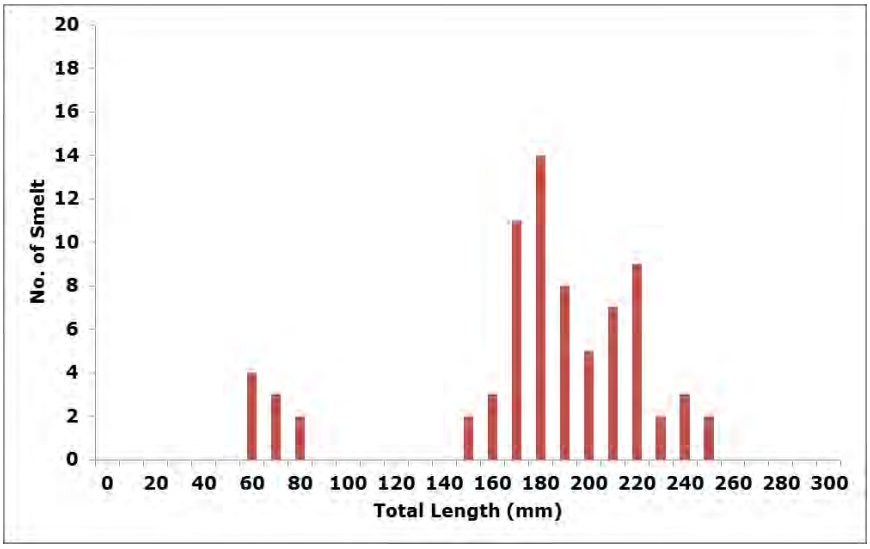


Figure 5.4. Length frequency distribution of smelt (n=75) captured during trawls on Waterford Harbour.

5.3 Seine Net Surveys

In addition to the trawling survey in Waterford Harbour undertaken for the IFI National Bass Programme, a number of seine net surveys for juvenile bass were undertaken at a number of coastal and estuarine locations (Rogerstown, Liffey, Slaney, Barrow, Dungarvan, M. Blackwater, Ballymacoda & Tralee Bay) during late summer and autumn 2015. Smelt were encountered at two of the sites, namely the Barrow (Fisherstown, n=35) and the Munster Blackwater (u/s Youghal, n=9). Smelt ranged in size from 50mm to 92mm.

Plate 5.3. Seine net survey in Tralee Bay.

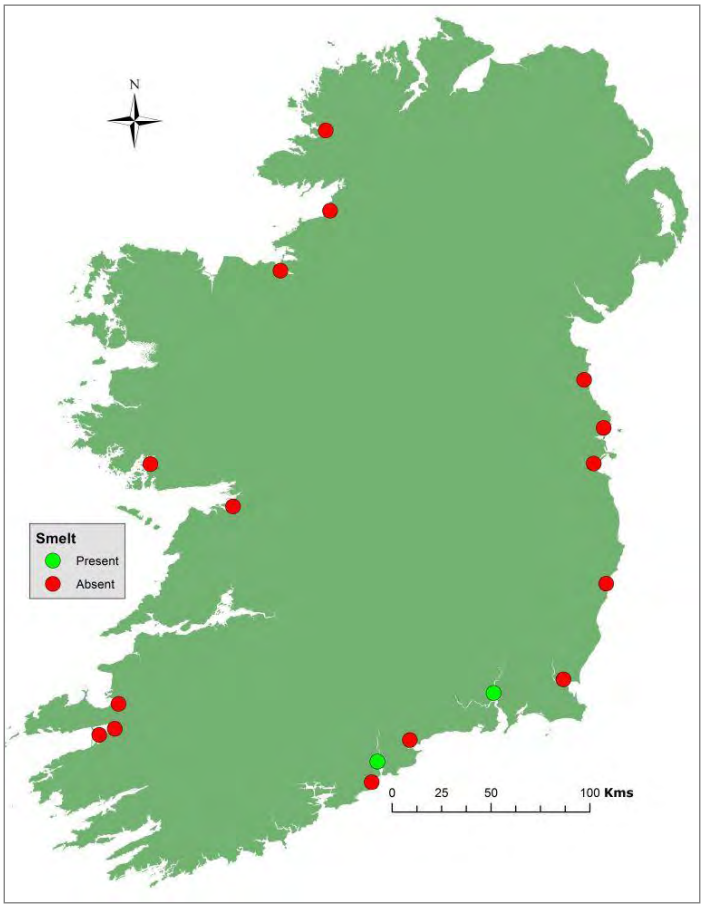


Figure 5.4. Location of bass seine net surveys during 2015 and associated incidence of smelt capture.

6. Char programme

6.1 Introduction

In order to expand the existing knowledge and gain an up to date picture of Arctic char (*Salvelinus alpinus*) populations, the Habitats Directive team undertake sampling on a number of lakes every year. In 2015, four lakes were surveyed in order to ascertain the status of char populations. Two of the lakes, Loughs Derkmore and Nalughraman were in Co. Donegal and the others, Loughs Reagh and Cumeenduff were located in Co. Kerry. Prior to the surveys little was known on the status of Arctic char in the lakes, apart from Lough Nalughraman which was last surveyed in 2009. The lakes in County Kerry were surveyed in order to investigate the presence of an Arctic char population. Loughs Reagh and Cumeenduff are within The Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment. This is an SAC for a number of plant and animal species including the three lamprey species, Killarney shad, salmon and otter (Figure 6.1 and Table 6.1). The SAC is designated for a number of Annex I habitats including oligotrophic waters containing very few minerals and oligotrophic to mesotrophic standing waters. These habitats are ideal to support char populations due to their lack of pollution and low nutrient levels. Lough Nalughraman is located within the Slieve Tooey/Tormore Island/Loughros Beg Bay SAC.

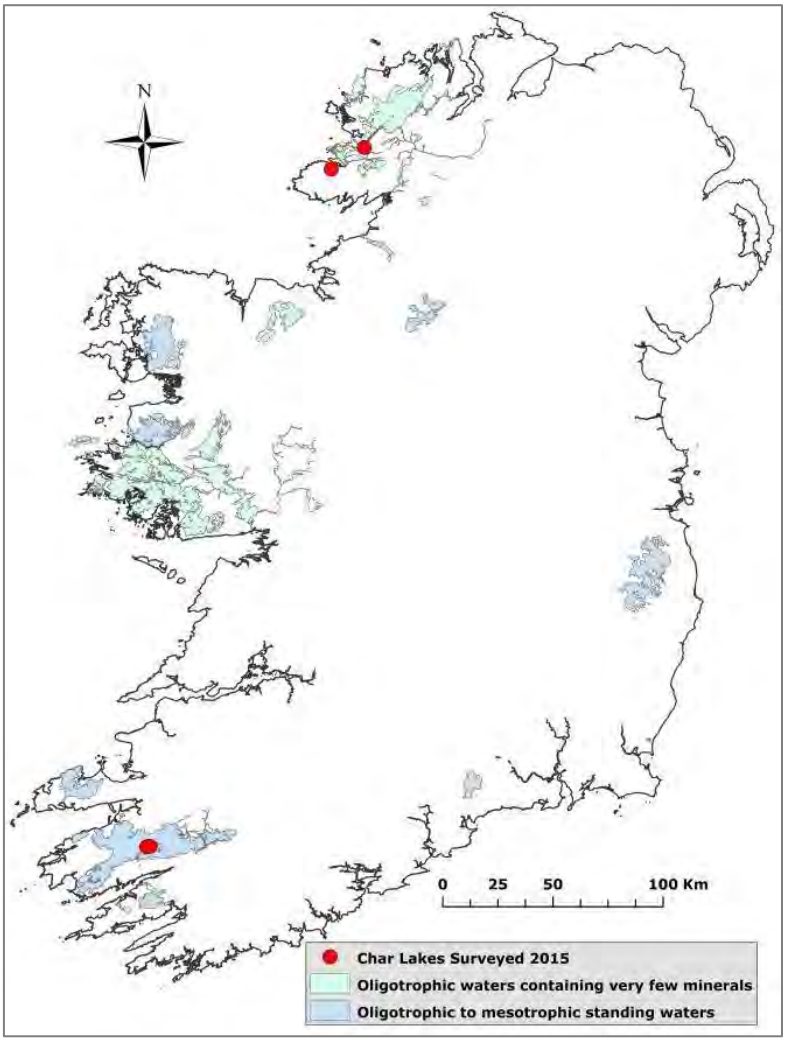


Figure 6.1. Map showing locations of lakes surveyed for Arctic char during 2015.

6.2 Materials and Methods

Lake surveys were undertaken using CEN Standard Guidelines for lake monitoring. Using the area and maximum depth of the lake the number of nets in the different depth zones was calculated (Table 6.1). Prior to each survey a bathymetric survey was undertaken in order to map the depth of the lakes. Using this information, a model of the lake was created. This yielded the different contours identifying the differing depth zones. A numbered grid was placed over the lake. Using this information, random net locations were chosen in the different depth zones. Three types of nets were used including fyke nets, benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets and surface floating monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (Table 6.2). The random net locations were uploaded to a handheld GPS (Global Positioning System). This GPS was used on site to determine where the nets were deployed. The lake depth was measured at the beginning and end of each net in order to position them in the correct depth zone. Nets were deployed in random directions in relation to the shoreline.

Table 6.1. Physical characteristics of the individual lakes, 2015.

	Lough Reagh	Lough Cummeenduff	Lough Derkmore	Lough Nalughraman
Area (hectares)	6	31	10	56
Maximum Depth (m)	6.2	10	17	35
SAC	3110&3130	3110&3130	-	-
Conductivity (µS)	45.2	46.3	115.9	60
Temperature (ºC)	13.3	14.6	12.6	12.2

3110 - Oligotrophic waters containing very few minerals of sandy plains.
3130 - Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Iso-to-Nanojuncete

Table 6.2. Number and type of nets deployed in different depth zones.

Net Type	Depth (m)	Lough Reagh	Lough Cummeenduff	Lough Derkmore	Lough Nalughraman
Benthic Nets	0-2.9	2	2	2	3
	3-5.9	2	3	2	3
	6-11.9		2	2	3
	12-19.9			2	2
	20-34.9				2
Surface Nets			1	2	2
Fyke Nets		2	3	2	2
Total		**6**	**11**	**12**	**17**

As the nets were retrieved, any fish which were alive were measured and a few scales were collected. The fish were then released back into the lake. The remaining fish were removed from the nets and the fish from each net were retained in a labelled plastic bag. These fish were frozen until such time that they were dissected. During the dissection process the species, length, weight, scales, sex, gonad maturity and stomach contents were collected. Scales were used to determine the age of the fish.

6.3 Results

In total four species of fish were recorded across the four lakes (Table 6.3). Arctic char were only recorded in Lough Nalughraman. Brown trout were present in all lakes. European eel were recorded in Lough Derkmore and one salmon was captured from Lough Cummeenduff.

Table 6.3. Number and species of fish captured in different nets and depth zones.

	Net Type	Lough Reagh	Lough Cummeenduff	Lough Derkmore	Lough Nalughraman
Brown Trout	**Benthic Nets**	56	125	10	39
Salmo trutta	**Surface Nets**	42	4		
	Fyke Nets	8	34	1	2
Salmon	**Benthic Nets**				
Salmo salmo	**Surface Nets**		1		
	Fyke Nets				
European eel	**Benthic Nets**				
Anguilla	**Surface Nets**				
anguilla	**Fyke Nets**			2	
Arctic Char	**Benthic Nets**				26
Salvelinus	**Surface Nets**				4
alpinus	**Fyke Nets**				

6.3.1 Lough Reagh

Lough Reagh is located within the Laune catchments in County Kerry. No comprehensive sampling survey had been undertaken prior to this investigation. Lough Reagh was sampled over one night on the 28th July 2015 (Plate 6.1).

Plate 6.1. Lough Reagh, July 2015.

Based on the bathymetric survey, six nets were deployed at predetermined locations (Figure 6.2).

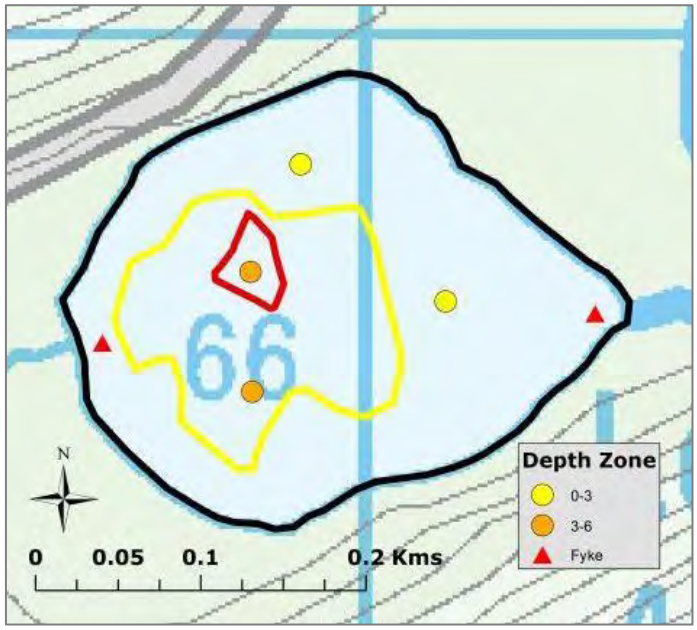


Figure 6.2. Map showing net locations for Lough Reagh, July 2015.

Brown trout were the only species of fish captured during the survey of Lough Reagh (Table 6.4). No Arctic char were caught during the survey.

Table 6.4. Number of brown trout captured by each gear type during the survey on Lough Reagh, July 2015.

Net Type	**Depth (m)**	Brown trout *Salmo trutta*
Benthic Nets	0-2.9	56
	3-5.9	42
Fyke Nets		8
Total		**106**

The length of brown trout caught varied between 8.5 and 23 centimetres (Figure 6.3). The smaller age classes indicate recent recruitment had occurred.

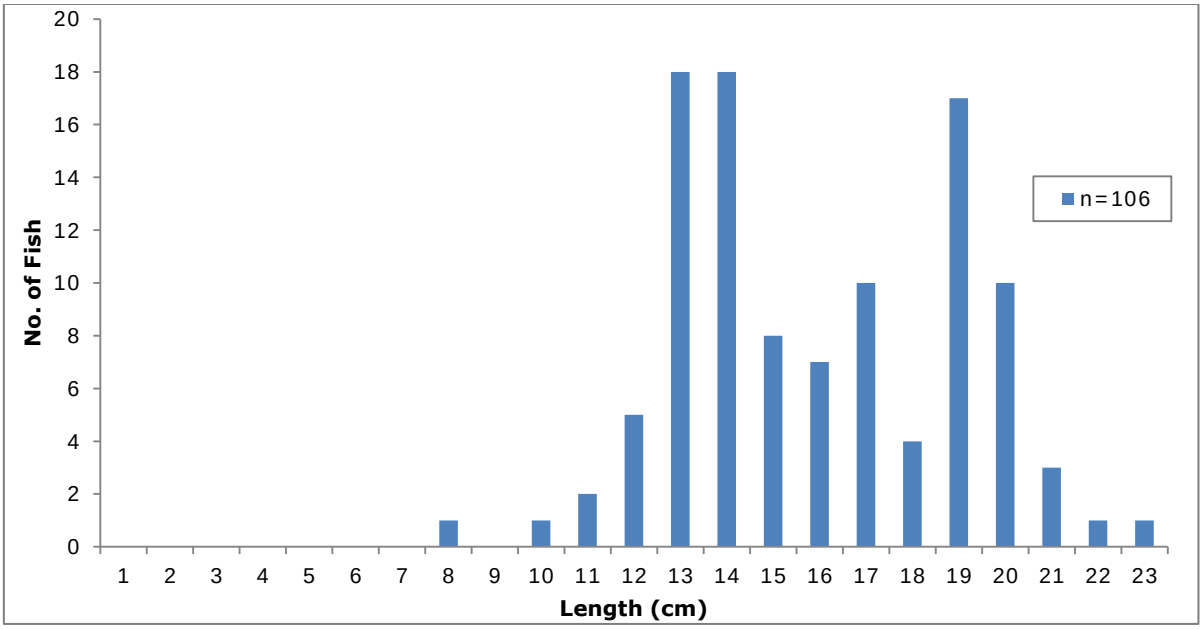


Figure 6.3. Length frequency of brown trout on Lough Reagh, July 2015.

The population of brown trout would be considered healthy with a number of sizes classes represented and good numbers of fish recorded. This is the first comprehensive study of Lough Reagh so there is no previous data to compare the current stock assessment with.

6.3.2 Lough Cummeenduff

Lough Cummeenduff is located within the Laune catchments in County Kerry. No previous survey of fish stocks had been undertaken prior to this investigation. Lough Cummeenduff was sampled over one night on the 29th July 2015 (Plate 6.2).

Plate 6.2. Lough Cummeenduff, July 2015.

Based on the bathymetric survey, eleven nets were deployed at predetermined locations (Figure 6.4).

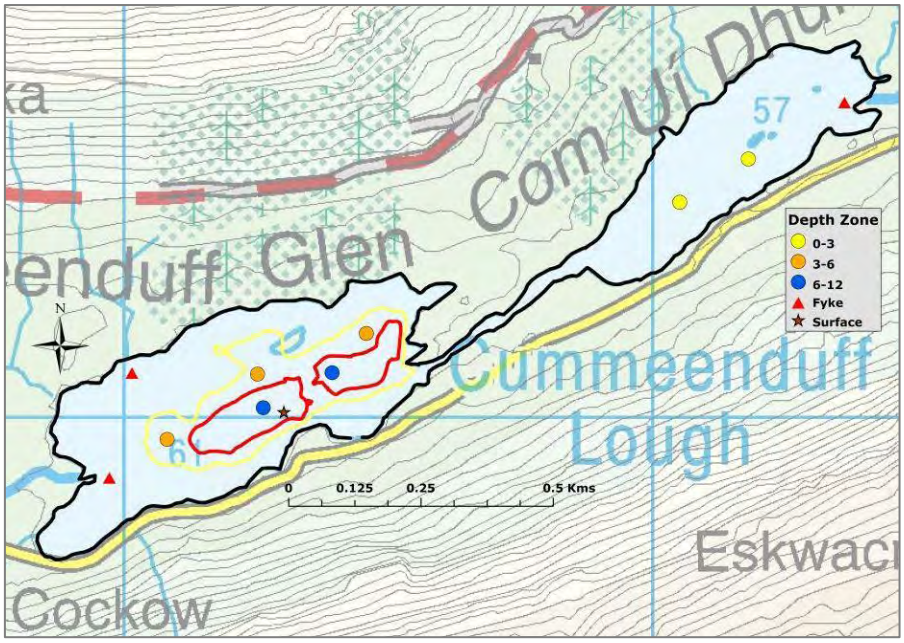


Figure 6.4. Map showing net locations for Lough Cummeenduff, July 2015.

Brown trout and one salmon were the only species of fish captured during the survey of Lough Cummeenduff (Table 6.5). No Arctic char were caught during the survey.

Table 6.5. Number of each fish species captured by each gear type during the survey on Lough Cummeenduff, July 2015.

Net Type	**Depth (m)**	Brown trout *Salmo trutta*	Salmon *Salmo salar*
Benthic Nets	0-2.9	40	
	3-5.9	70	
	6-11.9	15	
Surface Nets		4	1
Fyke Nets		34	
Total		**163**	**1**

The length of brown trout caught varied between 8 and 29 centimetres (Figure 6.5). The smaller age classes indicated recent recruitment has occurred. The salmon measured 66 centimetres.

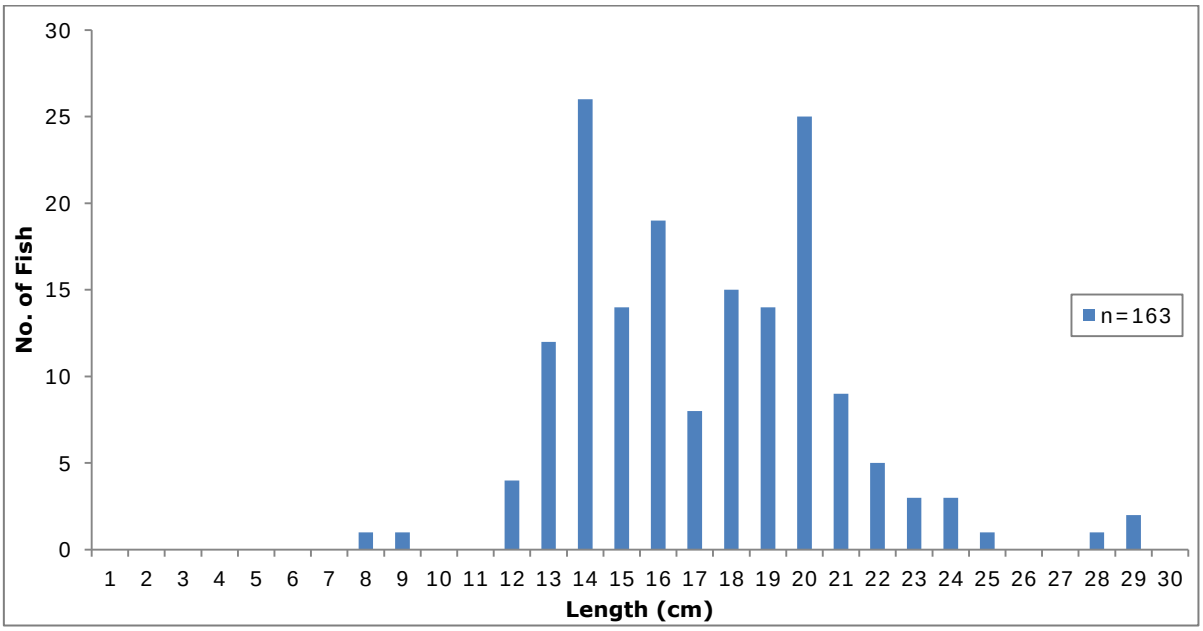


Figure 6.5. Length frequency of brown trout on Lough Cummeenduff, July 2015.

The population of brown trout would be considered healthy with a number of sizes classes represented and good numbers of fish recorded across a wide range of length categories. This is the first comprehensive study of Lough Cummeenduff so there is no previous data to compare the current stock assessment with.

6.3.3 Lough Derkmore

No Arctic char were captured during the survey of Lough Derkmore in September 2015. A total of 11 brown trout and 2 European eels were recorded (Figure 6.6 and Table 6.6).

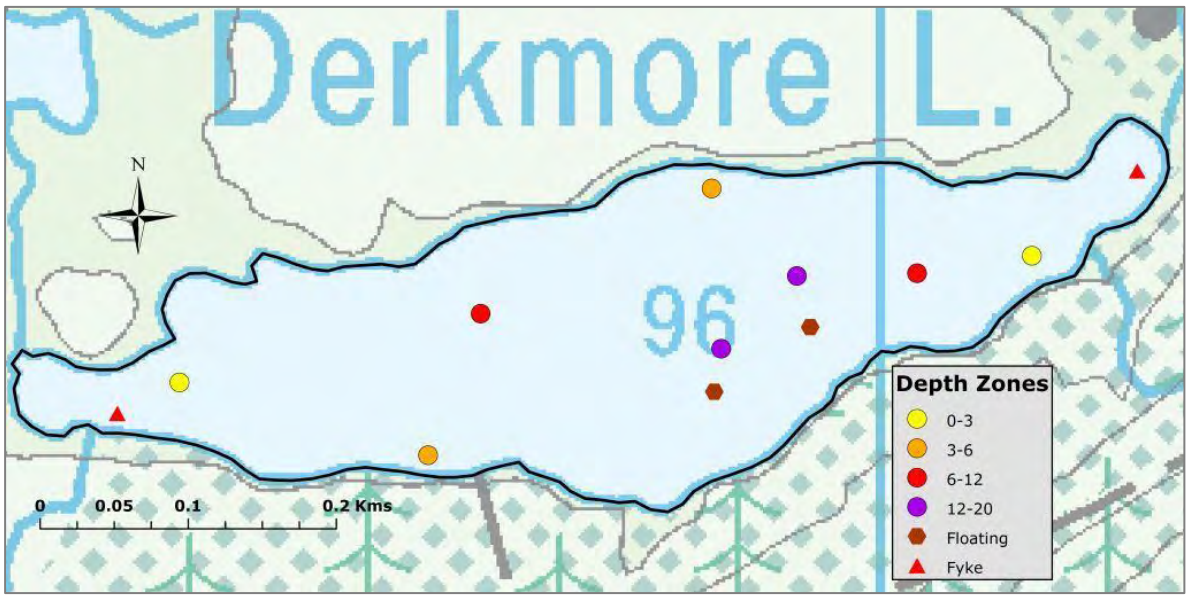


Figure 6.6. Map showing net locations for Lough Derkmore, September 2015.

Table 6.6. Number of each fish species captured by each gear type during the survey on Lough Derkmore, September 2015.

Net Type	**Depth (m)**	Brown trout *Salmo trutta*	European eel *Anguilla anguilla*
Benthic Nets	0-2.9	6	
	3-5.9	4	
Fyke Nets		1	2
Total		**11**	**2**

The length of brown trout caught varied between 19.2 and 44.3 centimetres (Figure 6.7). The eels measured 75 and 88 centimetres.

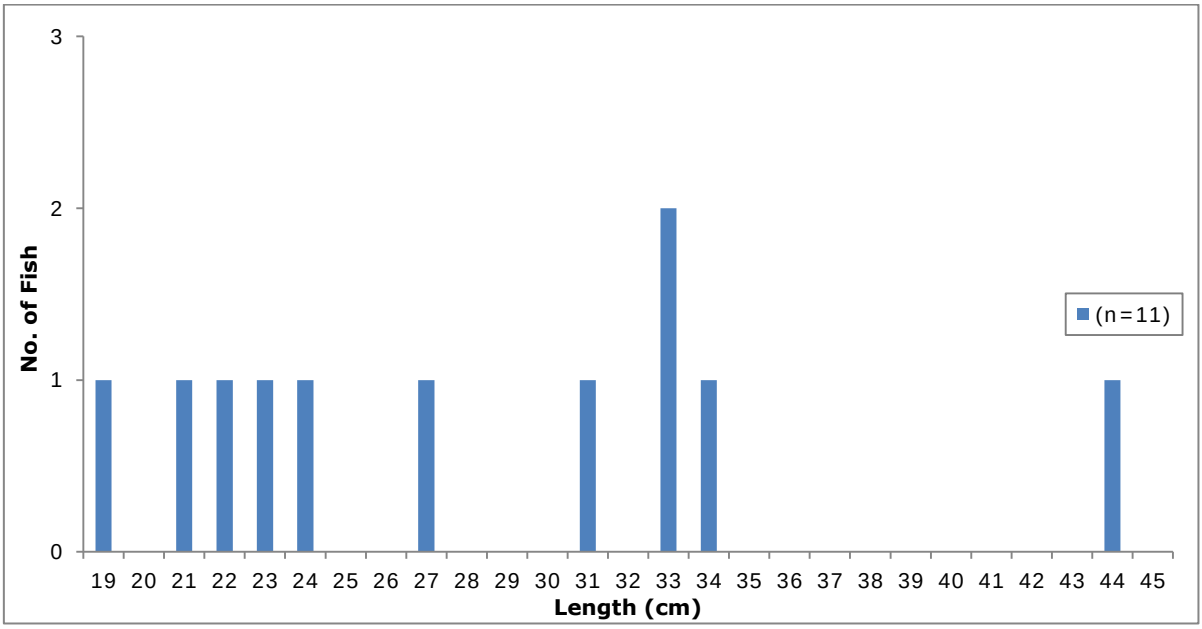


Figure 6.7. Length frequency of brown trout on Lough Derkmore, September 2015.

The population of brown trout would be considered poor with few fish captured during the survey. The lack of variation in size classes indicated no young fish and therefore little or no recruitment.

6.3.4 Lough Nalughraman

Lough Nalughraman is located within the Glen catchments in County Donegal. The lake was sampled on two previous occasions in 2005 and 2009 by the Habitats Directive team. Lough Nalughraman was sampled over two nights from the 22nd September 2015 (Plate 6.3).

Plate 6.3. Lough Nalughraman, September 2015.

Based on the maximum depth and area of the lake, seventeen nets were deployed at predetermined locations (Figure 6.8).

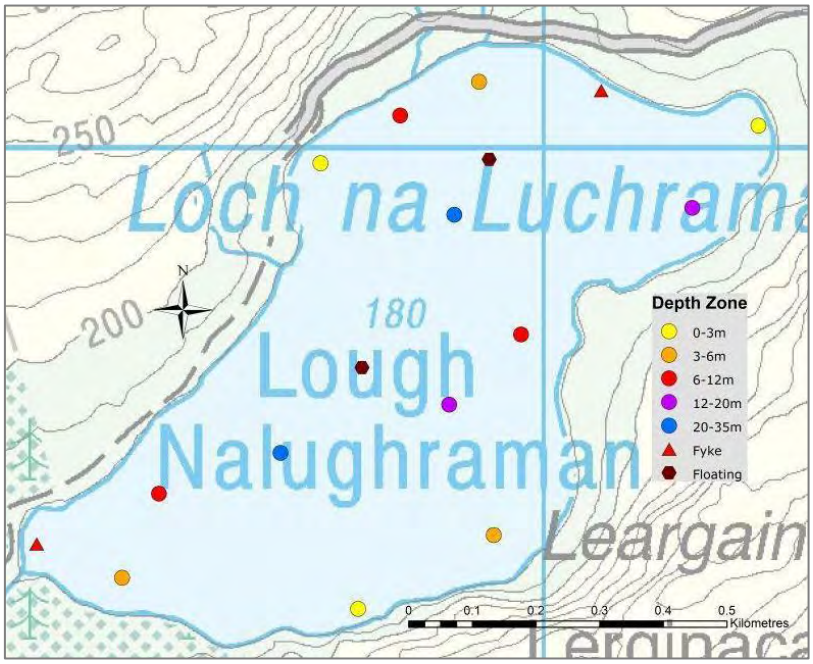


Figure 6.8. Map showing net locations for Lough Nalughraman, September 2015.

Brown trout and Arctic char were captured during the survey of Lough Nalughraman (Table 6.7).

Table 6.7. Number of each fish species captured by each gear type during the survey on Lough Nalughraman, September 2015.

Net Type	**Depth (m)**	Brown trout *Salmo trutta*	Arctic Char *Salvelinus alpinus*
Benthic Nets	0-2.9	23	8
	3-5.9	11	5
	6-11.9	5	5
	12-19.9		2
	20-34.9		6
Surface Nets			4
Fyke Nets		2	
Total		**41**	**30**

The length of brown trout varied between 13.8 and 27.4 centimetres during the 2015 survey (Figure 6.9). During the survey that was conducted in 2009 the variation in length was 14 to 49 centimetres (Figure 6.9).

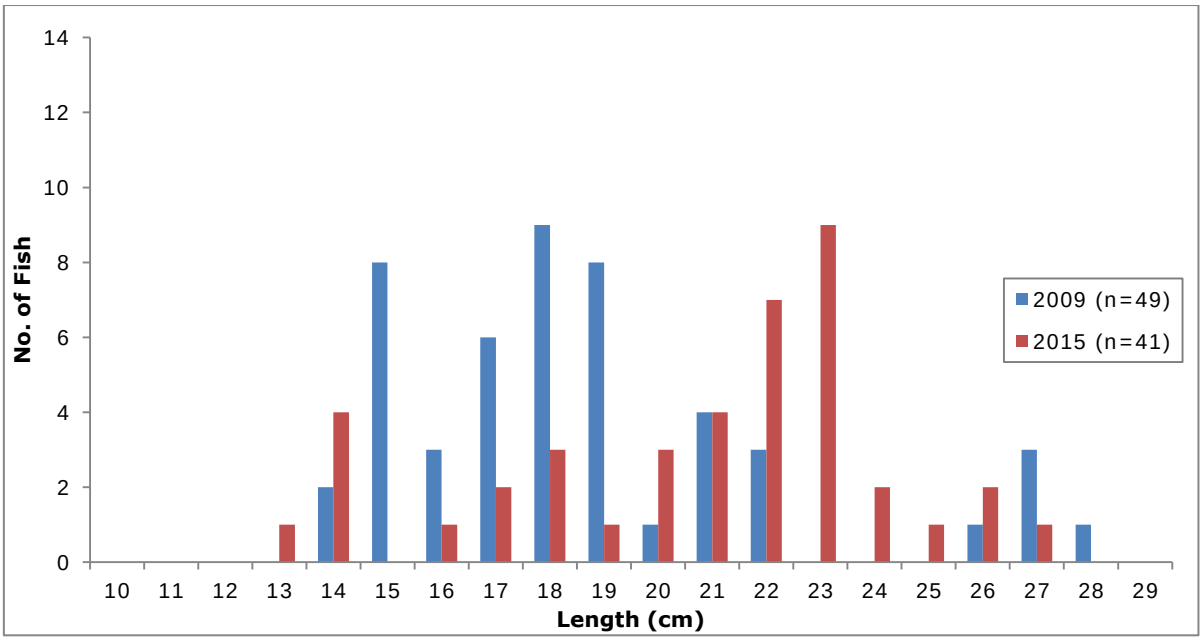


Figure 6.9. Length frequency of brown trout captured from Lough Nalughraman in September 2009 and 2015.

The length of Arctic char varied between 9.3 and 19.4 centimetres during the 2015 survey (Figure 6.10). When the survey was conducted in 2009 the variation in length was 7.2 to 19.2 centimetres (Figure 6.10).

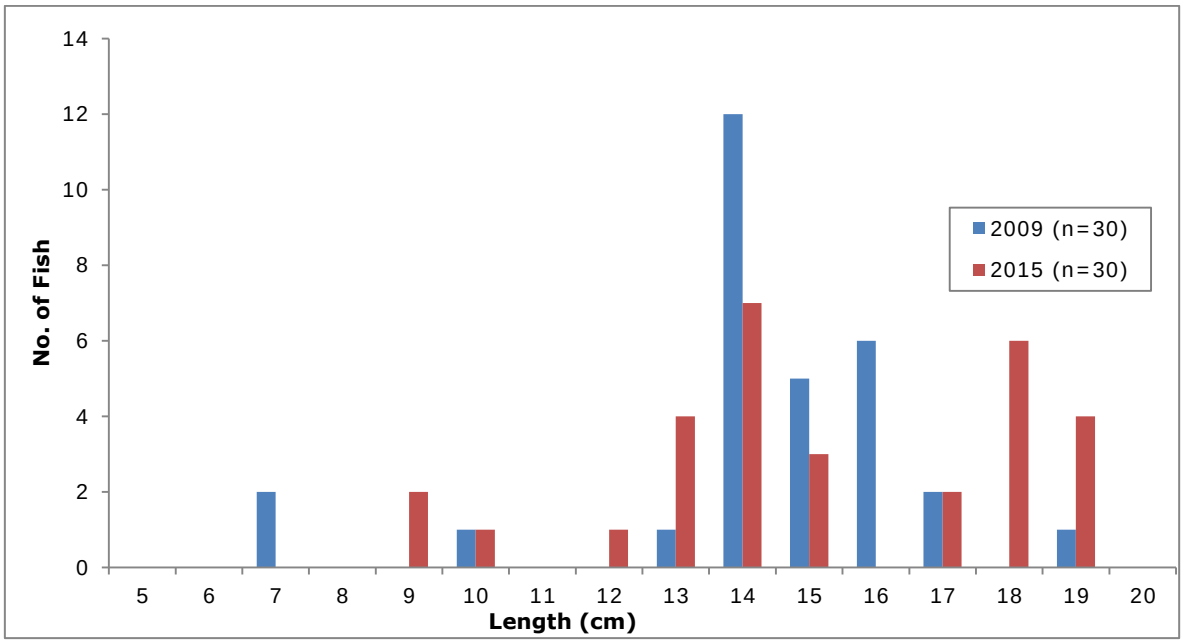


Figure 6.10. Length frequency of Arctic char captured from Lough Nalughraman in September 2009 and 2015.

Utilising information collected from the fish sampled across the four lakes, comparisons were made on the length versus weight and male to female ratio.

Up to approximately 25 centimetres, the ratio of length to weight for brown trout is similar (Figure 6.11). The largest number of bigger fish were captured on Lough Nalughraman.

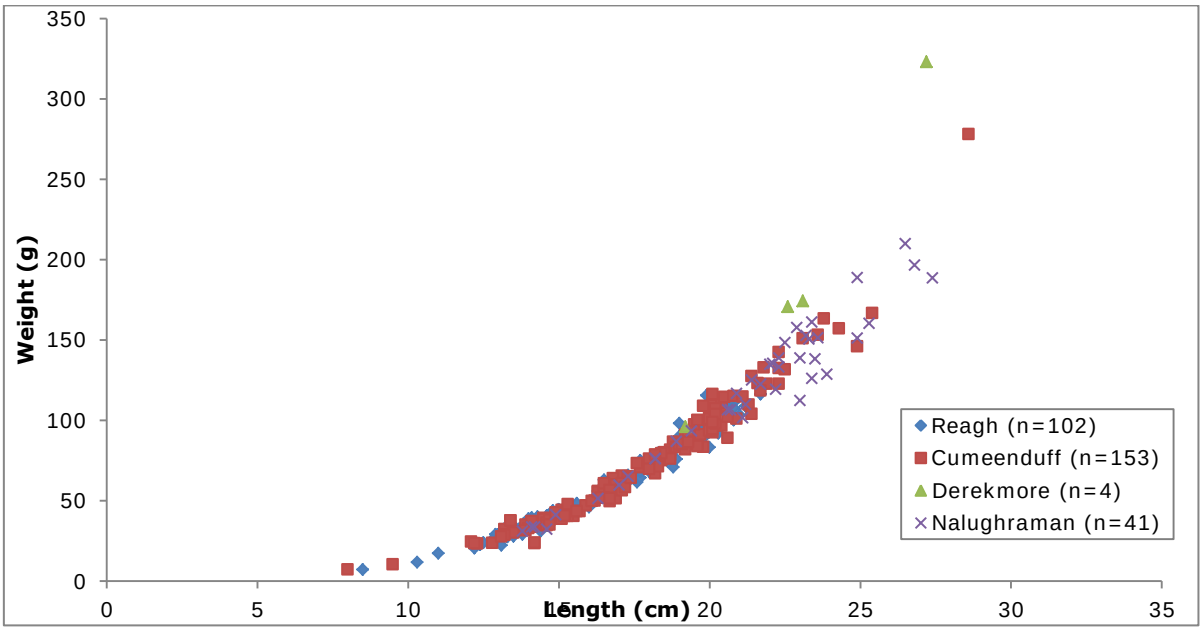


Figure 6.11. Length versus weight for brown trout in lakes surveyed during July and September 2015.

Length versus weight was calculated for the Arctic char captured on Lough Nalughraman (Figure 6.12)

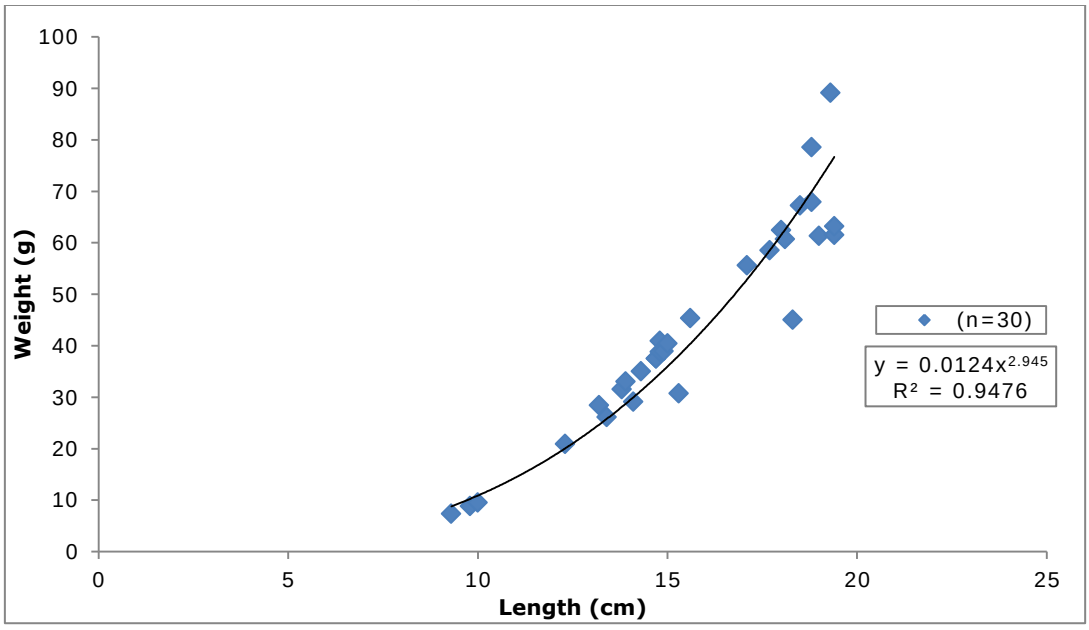


Figure 6.12. Length versus weight for Arctic char in Lough Nalughraman, September 2015.

The ratio of males to females of brown trout and Arctic char was compared across the four lakes (Table 6.8). Ratios of brown trout varied greatly across all four lakes. In relation to Arctic char on Lough Nalughraman, there were over three times more males than females.

Table 6.8. Ratio of males to females in brown trout and Arctic char samples.

	Brown trout				Arctic Char			
	Male	Female	Immature/ Unknown	n=	Male	Female	Immature/ Unknown	n=
Reagh	0.30	0.29	0.40	102				
Cummeenduff	0.45	0.33	0.22	153				
Derkmore	0.09	0.18	0.73	11				
Nalughraman	0.51	0.39	0.10	41	0.47	0.13	0.40	30

6.4 Discussion

The net surveys of the four lakes in 2015 were carried out to get information on the distribution of Arctic char and to gain an up to date picture of the fish population structure in these lakes. Arctic char were previously recorded from Lough Nalughraman during a survey in 2009. Prior to the 2015 surveys, there was no information on the presence or absence of a char population in Loughs Reagh, Cummeenduff or Derkmore. The lakes were chosen based on their location within an upland area, with surrounding lakes which support Arctic char populations. A total of four species were recorded in 2015, including Arctic char, brown trout, salmon and European eel. Arctic char were recorded from Lough Nalughraman but no char were captured in the net surveys of the other 3 lakes.

The bathymetric survey of the Kerry lakes revealed them to be relatively shallow overall, with no deep sections that could support a char population. As a relic species from the last ice age, Arctic char tend to favour deep, upland, oligotrophic lakes. Loughs Reagh and Cummeenduff did not meet the deep lake criteria.

With the exception of Lough Derkmore, the length frequency of brown trout in all four lakes displayed a number of size classes with young and old fish represented within the populations. Similar lengths versus weights were displayed in brown trout populations across the four lakes up to approximately 24 centimetres. There was a variation in the weight of larger fish. This variation may reflect the spawning condition or stomach contents of individual fish. In relation to Arctic char on Lough Nalughraman, a similar relationship between length and weight was identified across all size classes. The smallest fish captured at 9.3 cm was an indication of recent recruitment (Figure 6.10).

Eels were only captured on Lough Derkmore. In the previous survey of Lough Nalughraman in 2009 eels were present, however, none were caught during the 2015 survey.

The Habitats Directive team will undertake further investigations into lakes within SACs designated as Oligotrophic waters containing very few minerals of oligotrophic waters containing very few minerals and oligotrophic to mesotrophic standing waters SACs. Lakes characterised by these habitat types are ideal environments to support char populations. The aim for the Habitats Directive team is to survey further lakes from Igoe *et al.* 2003 in order to ascertain the status of Arctic char populations, whilst also gaining information on fish species composition in these lakes.

7. Hydromorphology – barriers to fish passage

Introduction

Salmonids, lamprey, eels and shad engage in substantial migrations, linking spawning areas and adult feeding and residency habitat. Individual species recruitment migrations can be from hundreds to thousands of kilometres while growing to maturity, before returning to their spawning grounds. These species can migrate significant distances in freshwater systems, an adaptation that maximised species dispersal within a watershed.

Barriers to fish passage are identified as either being natural or artificial. Natural barriers are generally of a geological origin (waterfalls) and it is implicit under the Water Framework Directive that such natural barriers remain undisturbed. Artificial barriers are of anthropogenic or man-made origin and take many forms. The majority were constructed to produce hydropower, supply water for human potable supply or to achieve a constant water level for leisure activities. These structures can have a pronounced effect on the flow regimes both down- and upstream of the barrier, affecting the resident biotic and abiotic elements. These structures can impede natural migration patterns of diadromous and catadromous fish species. As mitigation, fish passage structures are frequently inserted into weirs and dams. However, these facilities have tended to be designed to facilitate salmonids with little concern for other fish species.

Two barrier assessment methodologies are employed by IFI, the standard IFI field assessment sheet (now digitized) and the SNIFFER barrier assessment protocol. IFI will utilize these tools in a two-phase assessment. Initially the digitized IFI field assessment sheet will be used to developing a national GIS-based information layer on 'features' or structures or barriers in Irish rivers. The SNIFFER method will be a second-phase assessment, used for two main reasons – to examine fish passability at structures in the main stem of major SAC river channels and as a pre- and post-monitoring tool to assess impact of mitigation measures on any structure scheduled for modification or removal.

7.1 Barrier survey on the Barrow Catchment

Potential barriers on the main stem of the River Barrow and 32 of its sub-catchments were identified (n = 1254) using remote sensing i.e. a combination of historical maps and recent aerial imagery (Figure 7.1). The majority of these potential barriers were classified as bridges (948 of 1254). Fords and foot bridges identified using the historic 6 inch map layer accounted for a further 112 potential barriers. There were 87 potential barriers identified as weirs and sluices.
A spread sheet listing all of the potential barriers was compiled and all locations marked on Discovery maps for field use. The field surveys were undertaken using the IFI standard barrier assessment form on ruggedized laptops. These instruments collected GPS co-ordinates, photographs and provided drop-down forms to be filled at each survey site. Surveying was done by a 2 person team over 9 days and 214 listed potential barriers from the main stem and 6 sub-catchments were examined on-site (Figure 7.1, Table 7.1). 41 potential barriers were confirmed as

barriers to fish passage (Table 7.1, Figure 7.2) and were surveyed using the IFI digital field survey sheet. The extent to which a barrier affected different fish species was documented. On average there were 23 potential barrier sites examined per day.

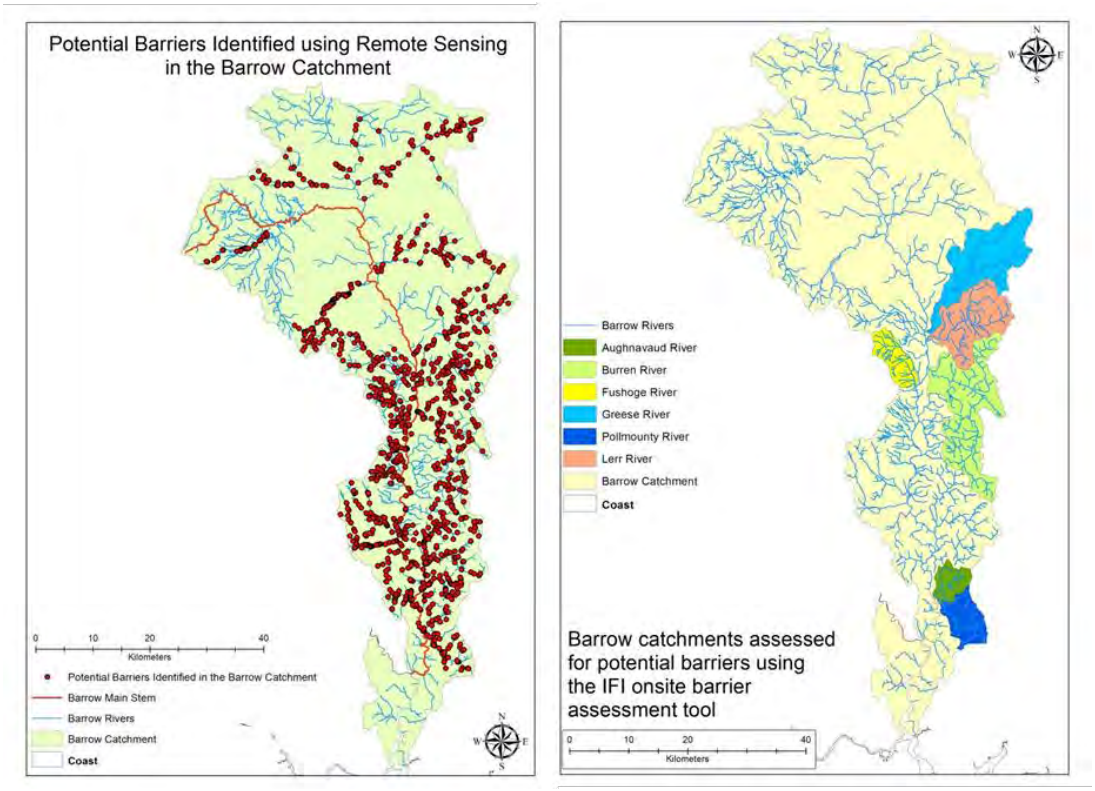


Figure 7.1. Potential barriers identified through remote sensing and Barrow sub-catchments assessed for potential barriers in the Barrow catchment.

A considerable number (47) of potential barriers identified using ArcMap were found to be located on channels that had very low water levels or that were in fact dry at the time of surveying. Where it was considered that these channels had insufficient water to support fish life the location of the potential barrier was noted as having "Low discharge" (Table 7.1). In 3 cases, potential barriers identified using ArcMap were not found during the field survey and they were marked as "Not found". There were also a number of instances where it was not possible to gain access to potential barriers these sites were marked as "No access".

Bridges accounted for 28 of the 41 potential barriers confirmed as barriers by on-site surveying. There were 89 bridges assessed as not presenting a barrier to fish and a further 47 bridges crossed water courses that had low discharge or were dry during the field survey. Other barriers to fish passage identified were 2 culverts, 2 sluices, 3 weirs and a ford, a navigation lock and a mill. From the 214 potential barriers identified remotely, 18.7% were considered on-site as potential barriers to one or more fish species and were surveyed.

Significant work remains to identify the remaining potential barriers in the Barrow catchment. Based on the 2015 desk-study, a minimum of a further 1040 potential barrier sites need to be assessed *in situ* to complete the Barrow barrier assessment programme (Figure 7.2). With a two-person team, this will take at minimum 43 working days in 2016.

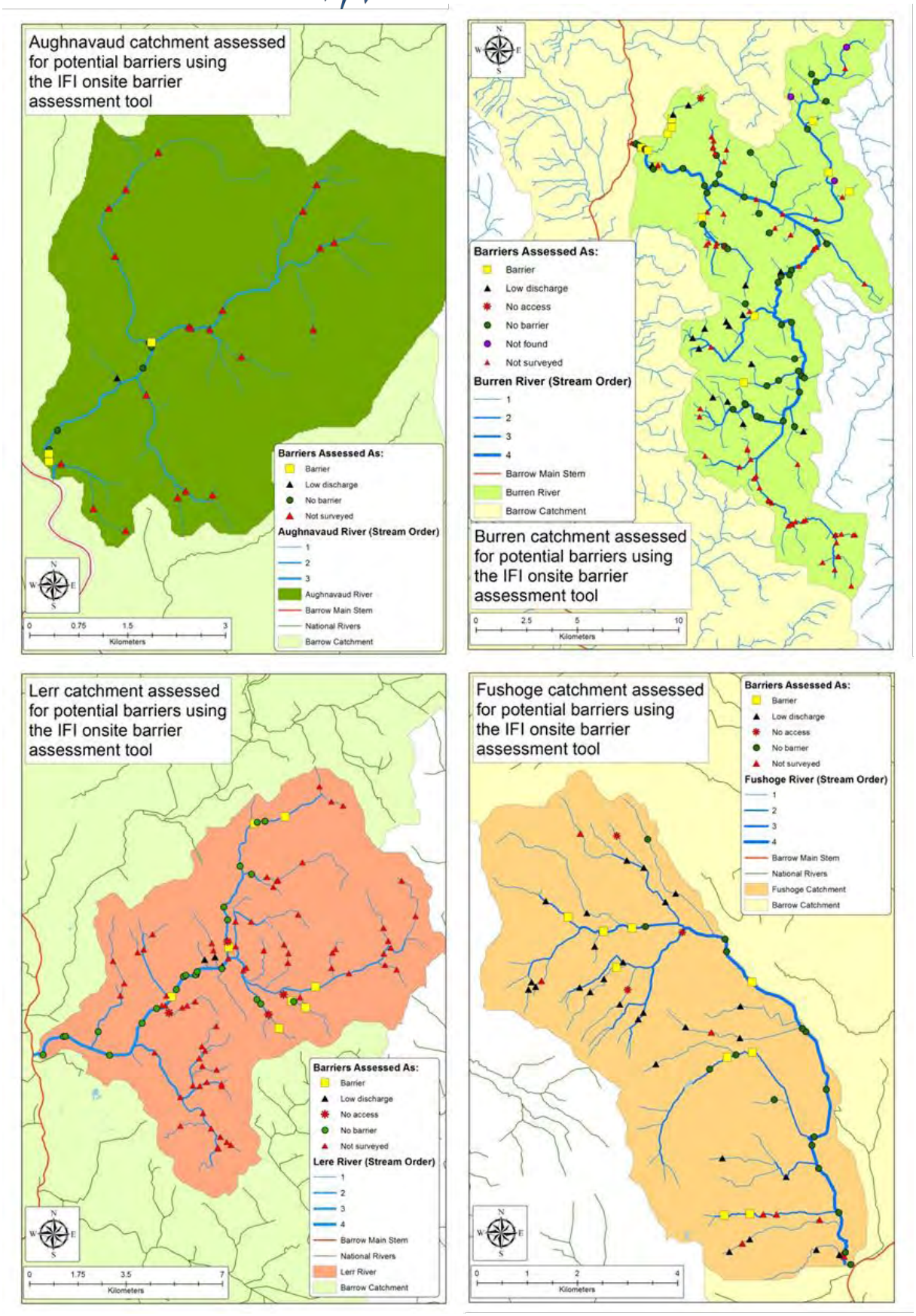


Figure 7.2. Barrier assessment output for the Aughnavaud, Burren, Lerr and Fushoge subcatchments in the Barrow Catchment.

Table 7.1. Results of in situ barrier assessments from seven barrow catchments. For each catchment the table gives total barriers identified from the remote sensing survey, results from on site assessment, total surveyed barriers from that catchment and total barrier number "not surveyed" or outstanding in that catchment. (Low discharge* very low water levels or dry at the time of surveying).

Catchment	Total Barriers Identified from Remote Survey	Barrier to Fish Passage	Not a barrier to Fish Passage	No access	Not found	Low discharge*	Total Surveyed	Not surveyed (outstanding)
Aughnavaud	30	3	5			1	9	21
Barrow	34	2					2	31
Burren	148	13	45	1	3	15	77	72
Fushoge	65	9	16	3		28	56	9
Greese	116	2	17	1		2	22	94
Lerr	106	8	24	4		3	39	67
Pollmounty	39	4	5				9	30
Total	**538**	**41**	**112**	**9**	**3**	**49**	**214**	**324**

7.2 Survey programme of barriers to migratory lamprey passage in SAC catchments

Potential barriers to sea and river lamprey passage in designated SAC's are being identified using a combination of historical mapping and remote sensing/modern aerial imagery. This initial screening process will identify potential barriers for onsite assessment. This is an ongoing project and desk study on the Boyne and Slaney SACs was undertaken in 2015 (Table 7.2, Figure 7.3).

Table 7.2. Potential barriers to Sea and River Lamprey passage identified in the Boyne and Slaney SAC's using remote sensing.

Catchment	River	Potential Barriers
Boyne	Boyne (main Stem)	17
Boyne	Kells Blackwater	10
Boyne	Monalty	1
Slaney	Bann [Wexford]	2
Slaney	Boro (River)	4
Slaney	Derreen	2
Slaney	Derry [Slaney]	3
Slaney	Slaney (main Stem)	12
Grand Total		51

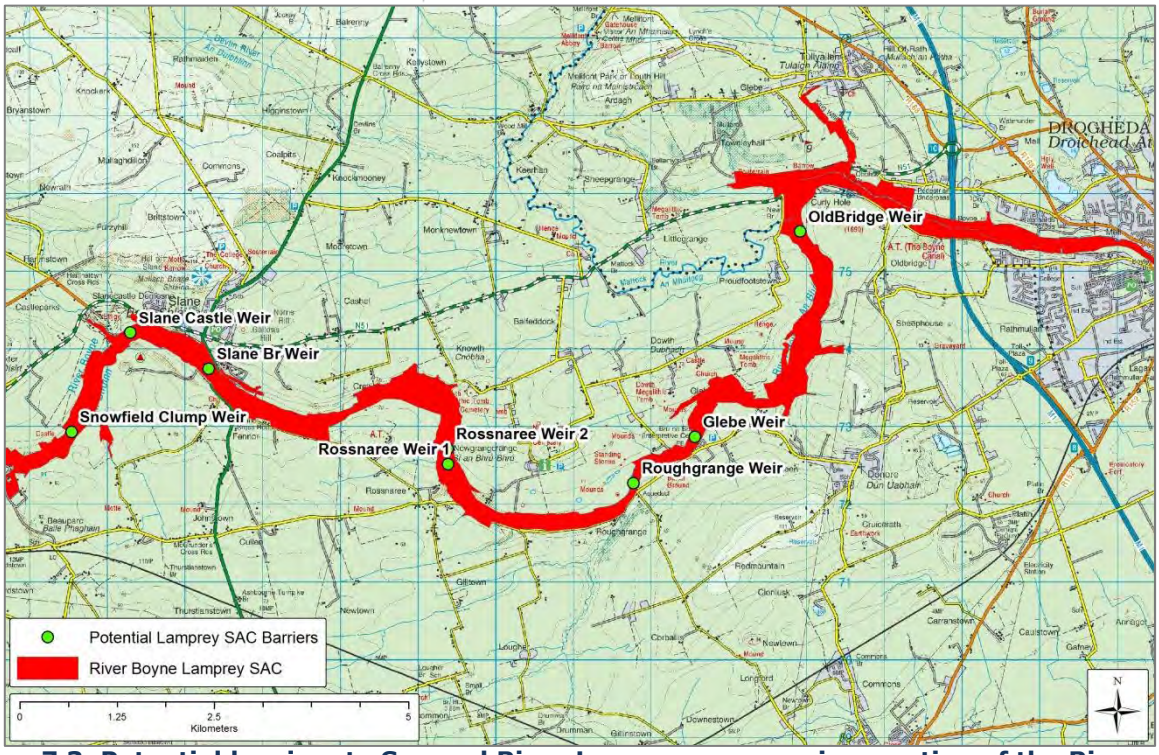


Figure 7.3. Potential barriers to Sea and River Lamprey passage in a section of the River Boyne and River Blackwater SAC (Slane to Drogheda).

In addition to the structured desk study, IFI has undertaken the more detailed SNIFFER barrier passability assessment on a national basis since 2013, largely on a priority basis. To data 14 of these surveys have been completed in lamprey-designated SACs (Table 7.3, Figure 7.4). Of the 14 sites, 5 were assessed as complete barriers, 7 as high impact barriers and 2 as low impact partial barriers. All 14 sites represent some form of barrier to lamprey migration.

Table 7.3. Structures assessed using the SNIFFER barrier assessment tool in lamprey SAC, March 2016.

ID	Catchment	River Name	Structure Name	GPS Easting	GPS Northing	Adult Lamprey (Current Conditions)
1	Barrow	Mountain Water River	Ballynattin Culvert	274426	150983	Low Impact Partial Barrier
2	Blackwater [Munster]	Munster Blackwater	Fermoy Weir	181152	98539	High Impact Partial Barrier
3	Blackwater [Munster]	Munster Blackwater	Careysville Weir	185000	99752	Complete Barrier
4	Boyne	Kells Blackwater	Martry Mill	280216	272313	Complete Barrier
5	Feale	Feale	Scartlee Weir	96063	132867	High Impact Partial Barrier
6	Feale	Smearlagh R	Bunglasha Br	101349	126623	High Impact Partial Barrier
7	Feale	Galey River	Ahavoher Br	106900	137077	High Impact Partial Barrier
8	Mulkear	Mulkear River	Annacotty Weir	164343	157534	High Impact Partial Barrier
9	Mulkear	Mulkear River	M7 Weir	164405	156693	Low Impact Partial Barrier
10	Nore	Nore	Castletown Weir	234044	192159	Complete Barrier
11	Nore	Kings River	Ballygaing Bridge	231770	144562	Complete Barrier
12	Slaney	Tuckmill Stream	Tuckmill Br Weir	287788	191473	Complete Barrier
13	Slaney	Slaney River	Ballycarney Br	296781	148837	High Impact Partial Barrier
14	Slaney	Slaney River	Cloughamon Weir	293313	154828	High Impact Partial Barrier

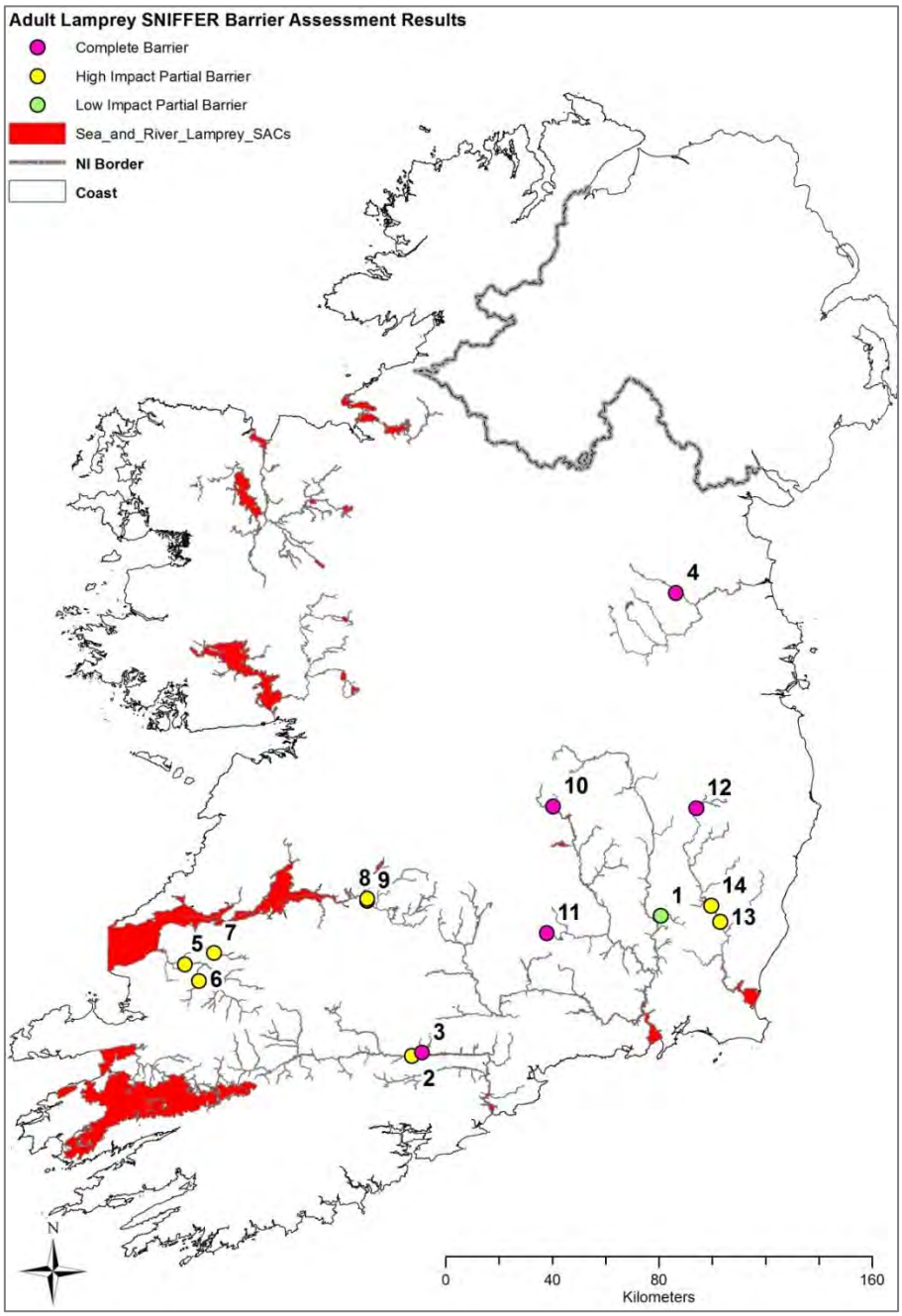


Figure 7.4. Locations and results of SNIFFER barrier assessment (Table 7.3) for Lamprey *sp.* at 14 sites in designated Lamprey SAC catchments.

With the completion of the potential barrier-screening program in Lamprey SAC's, a focused programme of SNIFFER barrier passability surveys will be undertaken. It is aimed to have SNIFFER surveys completed on all of the main stem migratory lamprey SAC channels by the end of 2018, the next Article 17 status reporting period to the EU under the Habitats Directive. A sea to source approach will be used to identify barriers with the greatest impact on migratory fish. This is in line with the view of IFI's working group on barriers, that mitigation of barrier impacts should proceed in an upstream direction in any catchment, commencing at the most downstream structure.

Where barrier mitigation or removal plans are implemented, IFI proposes that SNIFFER passability surveys be completed both before and following any mitigations.

8. Work Programme 2016 – 2018

The work programme for the coming years focuses on the lead up to the next status report for the Habitats Directive in 2018. In any one year the schedule is varied and multi-faceted involving a number of survey techniques depending on the fish species concerned and the time of sampling. The Habitats team use a range of established survey methodologies to assess status, while also incorporating more innovative technologies such as acoustic telemetry and genetics. The work programme is designed to glean as much information as possible on species distributions and population dynamics over the 6-year cycle. 2016 will see further collaboration with fisheries colleagues, educational institutions and other state agencies on new and existing projects to enhance our knowledge of the conservation fish species and their habitats.

Lamprey: Lamprey monitoring constitutes a significant component of the work programme in any one year in terms of time and input of resources. The principal focus is on larval lamprey assessment with a considerable effort also devoted to monitoring the spawning activities of adult river, brook and particularly sea lamprey.

A catchment-wide survey programme for juvenile lamprey is being implemented for the period 2013 – 2018. This involves repeat surveys of all the SACs first surveyed through NPWS funded studies in 2003 – 2007. To date, a number of large and smaller SACs have been surveyed, including the Corrib, Munster Blackwater, Boyne, Feale, Laune and Slaney (Table 8.1). Surveying of lamprey ammocoetes involves electric fishing of suitable habitat at the margins of rivers during late summer and the geographical spread of sites is well represented in each catchment. In 2016 it is intended to survey the Suir catchment and the River Bonet, which forms part of the Lough Gill SAC. Both of these systems are designated for the 3 species of lamprey found in Ireland.

Table 8.1 Programme of catchment-wide surveys for juvenile lamprey (2013 – 2018).

	Major SAC	No Sites	Small SAC	No Sites
2013	Corrib	125	Feale	46
2014	Munster Blackwater	133	Laune	33
2015	Boyne	108	Slaney	70
2016	Suir	144	Bonet	15
2017	Barrow	123	Mulkear	30
2018	Nore	101	Moy	83

In assessing lamprey status, an important element of the Article 17 reporting process is to determine the viability of a species on a spatial and temporal basis. In 2012, a series of index or reference channels were selected for monitoring juvenile lamprey over a 6-year cycle. These index sites were selected to give a good geographic spread, to include SAC rivers and, based on previously collected data, to represent good and poor status ammocoete channels outside

designated SACs. Survey work commenced in 2013 and it is hoped that repeat sampling will inform on whether populations are self-maintaining and whether there has been a range increase or decrease across the country or within individual catchments.

Monitoring of the migration and spawning activity of river lamprey has returned positive results for the Slaney and Avoca catchments in 2015. The inability to distinguish between river and brook lamprey larvae makes the collection of data on adult river lamprey more pressing. The focus for survey work in spring 2016 will be on the Aughrim, Avonbeg and Avonmore rivers within the Avoca catchment. Traps deployed in late 2015 will remain in place to investigate the winter migration of river lamprey to upstream spawning sites. Consideration will be taken of the location of barriers in identifying potential spawning sites and these sites will be visited regularly in early spring to collect a range of physical and biological data including redd counts, fish measurements and DNA samples.

Land-locked sea lamprey investigations on L. Derg, L. Conn and Muckross Lake in Killarney will be carried out throughout the summer of 2016. The team will continue to use angler-caught fish as a means of collecting data and this will be complemented by a range of other survey techniques from walk-over surveys to drift netting and electric fishing.

The negative impact of man-made barriers, particularly weirs, to the migration of spawning sea lamprey is a well-established phenomenon. Catchment-wide larval lamprey surveys have indicated low to zero level of occurrence for sea lamprey over the past number of years. For this reason, the Habitats team has deployed increased resources to the monitoring of sea lamprey spawning activity as a means of assessing their status. The main focus of attention has been on the selection of spawning hot-spots in the various SACs that can be visited on an annual basis to collect redd data. Float-over surveys by canoe and kayak have also played an important role in identifying new or potential spawning locations. The collection of water samples for eDNA analysis commenced in 2015 and it is hoped that this innovative technique will provide positive results in the coming years. As an extension of this work, IFI is part-funding and collaborating on a UCD-based post-doctoral project in 2016-18 that will use citizen science as a means of providing additional records on both migrating and land-locked sea lamprey in selected SACs. A further resource, in the form of IFI fish counters, has been identified as a potential method of extracting more information on the timing and extent of sea lamprey migrations in certain rivers. Discussions are currently in place with IFI colleagues regarding the transfer of data and the possible up-grading of a number of counter systems, notably on the Feale and Mulkear rivers.

Shads: Post larval shad surveys of estuaries in the south and south-east of Ireland have had mixed success over the past few years. While the method of sampling using plankton nets (bongo nets) does capture juveniles, numbers of individuals have been too low to comment on recruitment success, particularly from 2013 onwards. A multitude of factors mitigate against sampling effort including the small size of the fish, the extent of the sampling area, the uncertainty of spawning success, as well as environmental factors such as flood events and tidal influences. A review of results in relation to timing of surveys, water temperatures and flow conditions is on-going and will report by end- 2016 and this will inform future survey operations.

The Habitats team has been using acoustic telemetry to monitor the movements of adult Twaite shad in Waterford Harbour – Suir – Nore – Barrow complex since 2012. Fish for tagging have been obtained from local anglers and, if conditions are favourable, from netting exercises in Waterford Harbour from late winter and/or early spring. An array of acoustic receivers or listening stations has been deployed in the harbour, as far south as Passage East, and along the 3 sister rivers up to the tidal limits in each case. These annual studies have provided a very interesting picture of the movement patterns of adult shads throughout the spawning season while, at the same time, relating spawning activity to abiotic factors such as water temperature, flow and tidal regime. The tagging programme will continue in 2016 and two new receivers will be positioned further down the harbour from Passage East to obtain information on the movements of pre- and post-spawning shads at the more seaward end of the system. It is also the intent to trial new tags that have a longer life-span (approximately 15 months as opposed to 10 months) than former models and this will open up the possibility of tracking returning fish entering the harbour in the spring of 2017 to spawn.

A number of marine caught shad are received by the Habitats team each year as part of a collaborative venture between IFI and a number of other state agencies including the Marine Institute, the Sea Fisheries Protection Authority (SFPA) and Bord Iascaigh Mhara (BIM). Data from these fish and the details of when and where they were caught add to our limited knowledge on the movement patterns and habits of both Twaite and Allis shad at sea. The Habitats team intend to actively liaise with these organisations in 2016 and beyond in an attempt to gain as much information as possible to fill the many knowledge gaps.

Pollan: The seasonal sampling of pollan in L. Allen in 2015 returned useful results in terms of population status, structure and water column usage of this deep water lake species. Complementary hydroacoustic studies carried out by IFI's WFD team on the pollan lakes of L. Derg, L. Ree and L. Allen in recent years, have prompted the use of pelagic nets for assessing status in these lakes. Following the successful programme on L. Allen, attention will be turned to L. Ree and L. Derg, where similar seasonal netting programmes will be implemented in 2016 and 2017 respectively.

Arctic char: The status of char in Ireland is being assessed in a long-term monitoring programme that was initiated in 2009. Using historical data from various lake studies in the past, the Habitats team is systematically surveying lakes on an annual basis and, to date, these surveys have helped to update records on this species. A number of lakes in the west and north-west of the country will be surveyed in 2016 using the standard multi-mesh gill netting technique used by IFI's WFD team.

Smelt: Annual bongo-netting surveys for post-larval shad in Waterford Harbour and the sister rivers of the Barrow, Nore and Suir have the additional benefit of capturing juvenile smelt. Surveys are carried out during the period of June – August, at which point, the young-of-year smelt are of a size easily captured. The particularly high numbers of smelt captured from the River Suir in 2015 is encouraging and, following a review of the current survey methodology, further sampling will be carried out over the coming years. As part of IFI's National Bass Programme, the Habitat's team

have been able to obtain adult smelt samples from autumn trawling surveys around the country. Collaboration with the marine sport fish team on these surveys is set to continue for the foreseeable future.

Project Personnel and Acknowledgements

Restructuring within the R&D team in IFI in early 2015 saw some changes occurring in the personnel of the Habitats team. Mr. Daniel Cierpial moved from the team, following his sterling work on bringing the databank of smelt and shad scales up to date, to the National Rivers and Lakes Survey team. Dr. Tara Gallagher joined the Habitats team as Research Officer and Mr. Brian Coghlan joined the team with a particular role in hydromorphology as it applies to fish passage and assessment of barrier impacts. Dr. James King, Ms. Nicola O'Gorman and Dr. Sean Rooney remained with the Habitats team.

In all waters surveyed, the team received full support from our colleagues within the individual IFI River Basin Districts (RBD) and thanks are due to the RBD Directors and their Inspectors, who organised logistics and support, and to officers within each area where surveys were undertaken. The R&D Division recruited staff on 6-month contracts to assist in a series of project areas. Dr. Fiona Bracken and Dr. Fintan Egan worked with the Habitats team during 2015. Both became an integral part of the Habitats Directive's survey team, contributing to catchment-wide larval lamprey surveying and to desk- and field work assessing the distribution of barriers to fish passage in the Barrow catchment.

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