LOUGHS AGENCY OF THE FOYLE CARLINGFORD AND IRISH LIGHTS COMMISSION

European Smelt (Osmerus eperlanus L.) of the Foyle Area

Monitoring, Conservation & Protection

Loughs Agency of the Foyle Carlingford and Irish Lights Commission
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An updated status report on European smelt in the Foyle area from 2012-2017.

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Report Reference LA/ES/01/18
CITATION: Niven, A.J, McCauley, M. & Armstrong, F. (2018) European Smelt of the Foyle Area. Loughs Agency, 22, Victoria Road, Derry~Londonderry

DOCUMENT CONTROL

Name of Document	European Smelt (*Osmerus eperlanus* L.) of the Foyle Area				
Author (s):	Art Niven, Mark McCauley & Fearghail Armstrong				
Authorised Officer:	John McCartney				
Description of Content:	Fish Stock Assessment				
Approved by:	John McCartney				
Date of Approval:	February 2018				
Assigned review period:	N/A				
Date of next review:	N/A				
Document Code	LA/ES/01/18				
This documents comprises	**TOC**	**Text**	**List of tables**	**Table of Figures**	**No. Appendices**
	X	X	X	X	

Version Control Table

Version No.	Status	Author (s)	Reviewed by	Approved by	Date of issue
Version 1	Draft	A. Niven, M. McCauley & F. Armstrong	John McCartney	John McCartney	28/2/2017
Revision 2					
Revision 3					

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ACKNOWLEDGEMENTS

The Loughs Agency sponsoring departments, board and staff are gratefully acknowledged for the funding, support and assistance provided to conduct fish stock assessments and status reporting in the Foyle and Carlingford areas.

Specifically Fishery Officers David Robinson, Emmett Carten and David O'Brien for assistance with conducting the 2012 sampling on the River Faughan and River Roe, Fishery Officers Liam McCallion & Rod Collins for assistance with conducting the 2016 sampling on the River Foyle, River Finn and River Deele and to Ian Olphert, Tommy McAree and Kris Kennedy for assistance with conducting the 2017 sampling on the River Mourne.

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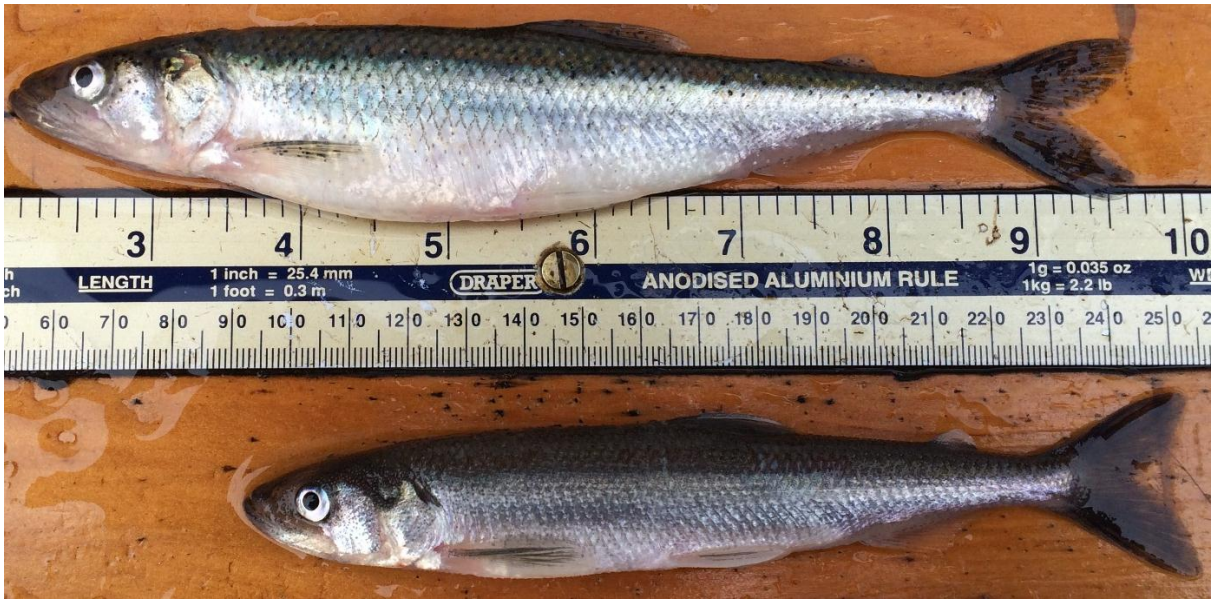

EXECUTIVE SUMMARY

Biological data, temporal and spatial distribution of European Smelt (*Osmerus eperlanus* L.) caught as part of targeted surveys carried out on the River Faughan, River Roe and River Foyle and tributaries in 2012, 2016 and 2017 are presented in this report. This follows on from baseline surveys of Foyle smelt populations conducted in 2010.

Smelt have been recorded previously from a number of areas within the Foyle system including Coolkeeragh Power Station water intake (Vickers and Watson 1974 & Vickers, 1974) and the estuaries of the River Faughan and River Roe which discharge directly into Lough Foyle (P.Moorehead, Pers com).

This report provides information on localised distribution within the River Roe, River Faughan, River Foyle and its tributaries. A previously unreported spawning location has been identified during the 2017 survey with significant numbers of Smelt recorded on the River Mourne in Strabane for the first time.

The rationale for developing conservation and protection efforts are also presented. Localised threats are also presented with gravel and substrate dredging on the River Foyle highlighted as one particular issue of significant concern. In 2016 during the Smelt survey on the River Foyle a previously unreported population of the invasive Asian Clam, *Corbicula fluminea* was recorded for the first time. Subsequent distribution and abundance surveys have been conducted on this new threat to local biodiversity within the Foyle area.

1.0 INTRODUCTION

The Loughs Agency previously reported on Foyle area European smelt (*Osmerus eperlanus* L.) stocks in 2011 (Niven, 2011). The baseline surveys of the River Foyle, River Finn, River Deele and Burndennet River conducted in 2010 were presented in addition to data collected from a cooling water intake on the tidal River Foyle in 2008 and 2009. The data collected from 2008 to 2010 contributed towards the Irish Red List, reclassifying the status of European smelt in Ireland from Vulnerable to of Least Concern (King et al, 2011).

European smelt were first recorded in the Foyle area in 1973 (Vickers, 1974) during monitoring conducted by the Foyle Fisheries Commission at the Coolkeeragh Power Station intake screens. At that time smelt had only previously been reported in Ireland from the Shannon. Since then smelt have been reported from the River Suir, River Nore, River Barrow, Munster Blackwater and River Slaney.

All Irish smelt are anadromous moving between estuarine/marine conditions and freshwater to reproduce (Doherty and McCarthy, 2004). At a European scale smelt are found in estuaries from Norway to north western Spain and the Baltic.

From a conservation and protection perspective accurate knowledge of the local spatial and temporal distribution, abundance and habitat utilisation is required in order to protect smelt populations from anthropogenic impacts and to ensure conservation through appropriate regulation. Data generated from these studies will complement other data collected at an all-Ireland scale and will contribute towards the knowledge base and future conservation of smelt populations in Ireland.

Smelt are known to spawn from January to April in large clean rivers. Water temperature and moonlight are the main factors affecting timing of spawning runs. Water temperature needs to be in the range of 4-9^{o}C (Quigley et al, 2004).

One of the key recommendations from the 2010 Loughs Agency Baseline Survey report was to instigate temporal surveys on other unsurveyed rivers within the Foyle area. In 2012 the Loughs Agency targeted the Roe and Faughan estuaries and tidal sections around spawning time. In 2016 a re-survey with expanded temporal resolution to the 2010 baseline survey was conducted and in 2017 a

baseline survey was conducted of the River Mourne. The results of the outlined studies are presented in this report.

2.0 METHODS

The targeted smelt surveys conducted around spawning time in 2012, 2016 and 2017 followed the methods used in the 2010 baseline surveys. Gangs of fyke nets were deployed at a slight angle to the flow in a variety of locations. Table 1 below outlines the year, river name, net ID and dates of deployment. All fyke nets were deployed for one day/night period.

YEAR	RIVER NAME	NET ID	DATE DEPLOYED
2012	River Faughan	F1 & F2	21/2/12
2012	River Roe	R1 & R2	21/2/12
2012	River Faughan	F1 & F2	27/2/12
2012	River Roe	R1 & R2	27/2/12
2012	River Faughan	F1 & F2	6/3/12
2012	River Roe	R1 & R2	6/3/12
2012	River Faughan	F1 & F2	13/3/12
2012	River Roe	R1 & R2	13/3/12
2012	River Faughan	F1 & F2	20/3/12
2012	River Roe	R1 & R2	20/3/12
2012	River Faughan	F1 & F2	26/3/12
2012	River Roe	R1 & R2	26/3/12
2016	River Finn	Fyke 1 & Fyke 2	10/3/16
2016	River Finn	Fyke 1 & Fyke 2	16/3/16
2016	River Finn	Fyke 1 & Fyke 2	23/3/16
2016	River Finn	Fyke 2	8/4/16
2016	River Deele	Fyke 3	10/3/16
2016	River Deele	Fyke 3	16/3/16
2016	River Deele	Fyke 3	23/3/16
2016	River Deele	Fyke 3	8/4/16
2016	River Foyle	Fyke 4, 5 & 6	10/3/16
2016	River Foyle	Fyke 4 & 5	16/3/16
2016	River Foyle	Fyke 4 & 5	23/3/16
2016	River Foyle	Fyke 4 & 5	8/4/16
2017	River Mourne	Fyke 1, 2 & 3	14/3/17
2017	River Mourne	Fyke 2 & 3	24/3/17

Table 1. Netting effort and location 2012, 2016 and 2017.

In 2012 an extensive temporal study was carried out at two locations each on both the lower tidal stretches of the River Roe and Faughan. Netting was conducted weekly over a six week window around expected spawning time covering the period from the 21st February to 26th March 2012.

Fig 1. 2012 temporal smelt survey on the River Roe (top) and River Faughan (bottom)

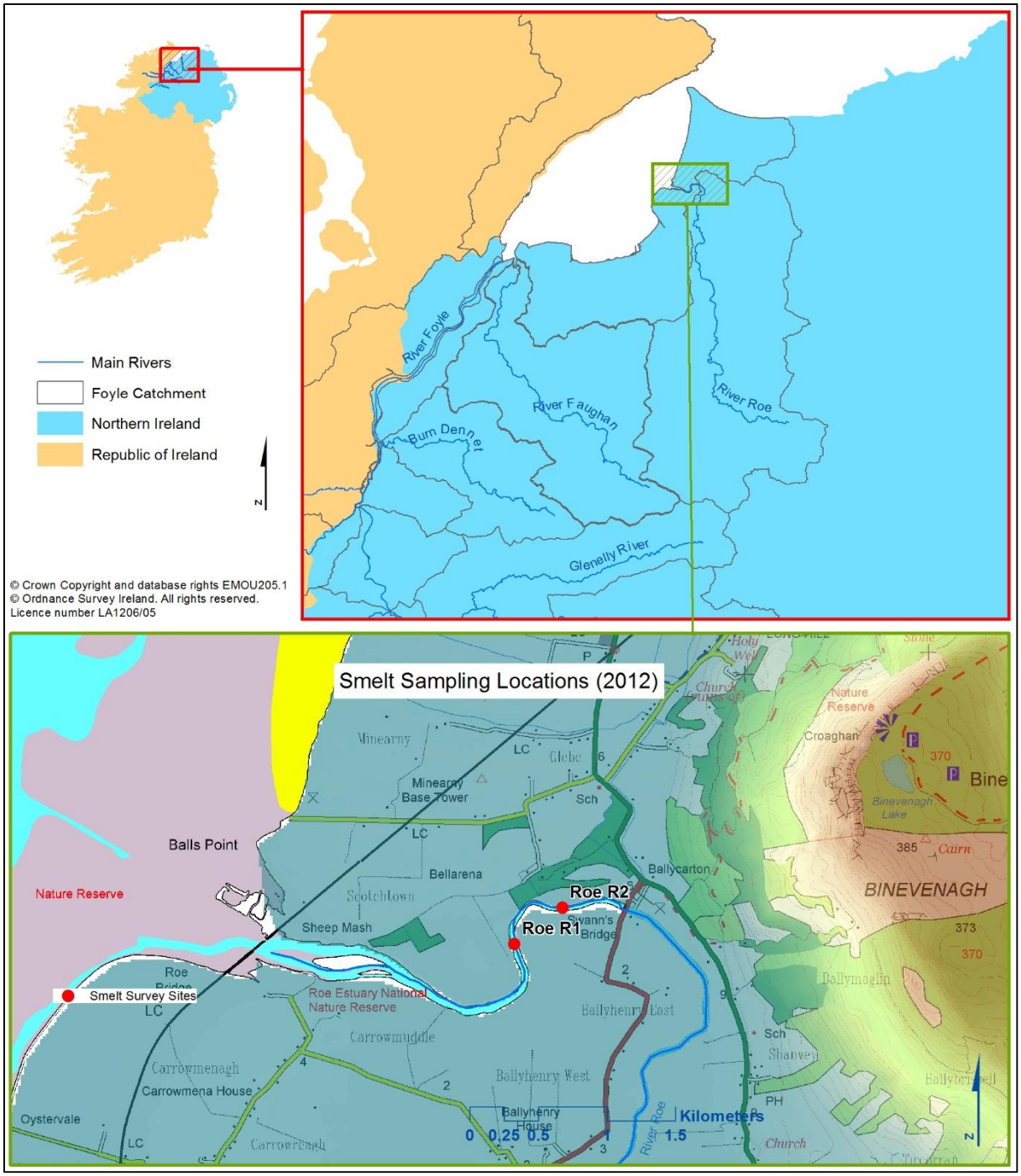

Fig 2. Map & picture showing Smelt sampling locations on the River Roe

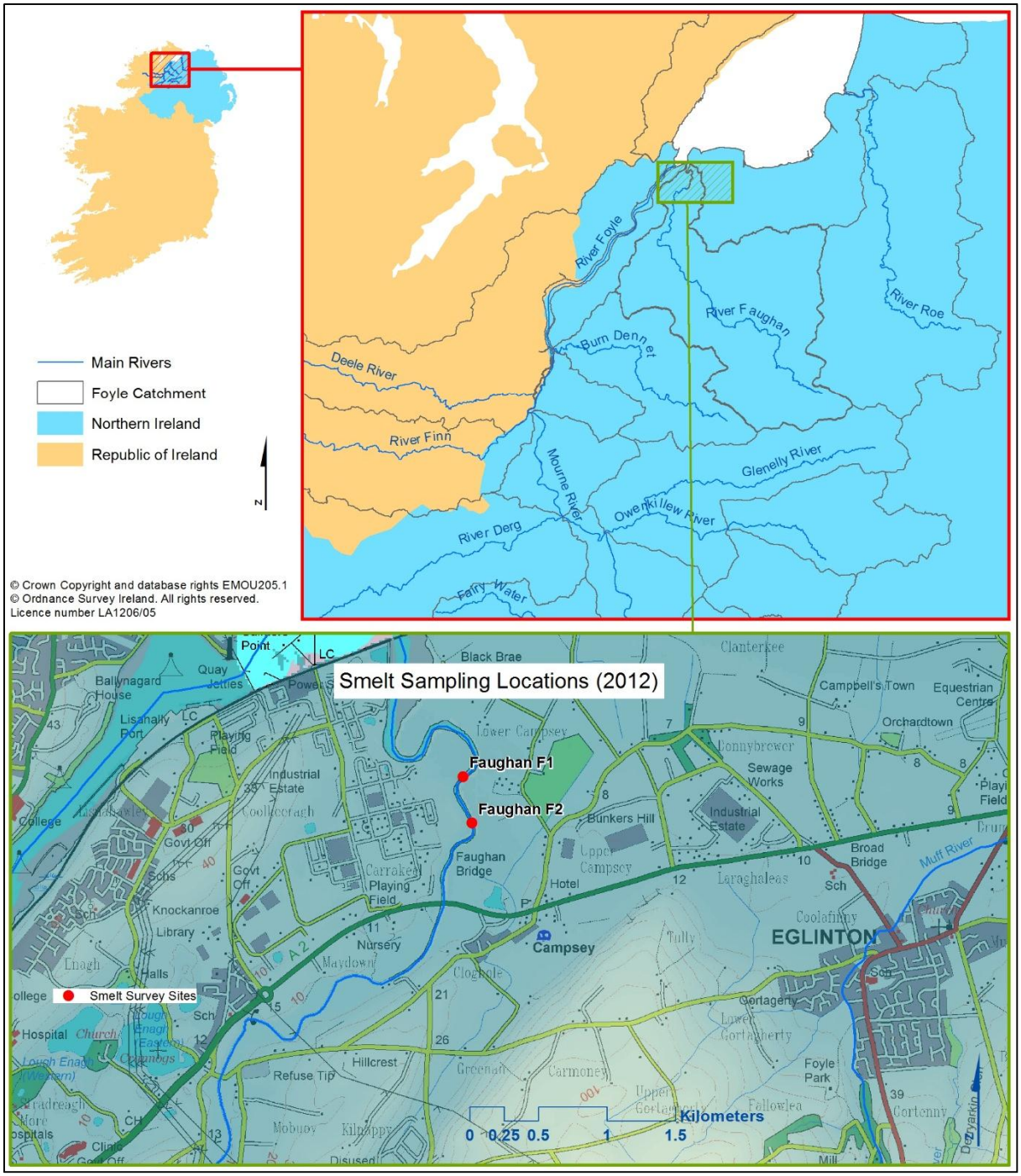

Fig 3. Map showing Smelt sampling locations on the River Faughan

In 2016 a re-survey of the 2010 survey was conducted on the River Finn, River Deele and River Foyle with an increase in temporal distribution of the surveys. Netting was conducted over four weekly sampling intervals covering the period 10th March to the 8th April. Fyke 1 on the River Finn, the furthest upstream net was dropped after three weeks with no Smelt caught and Fyke 6 on the River

Foyle was dropped after the first week due to the discovery of the invasive species *Corbicula fluminea* (Asian clam) and logistical issues.

Fig 4. 2016 survey locations on the River Finn

Fig 5. 2016 survey location on the River Deele

Fig 6 2016 survey location on the River Foyle

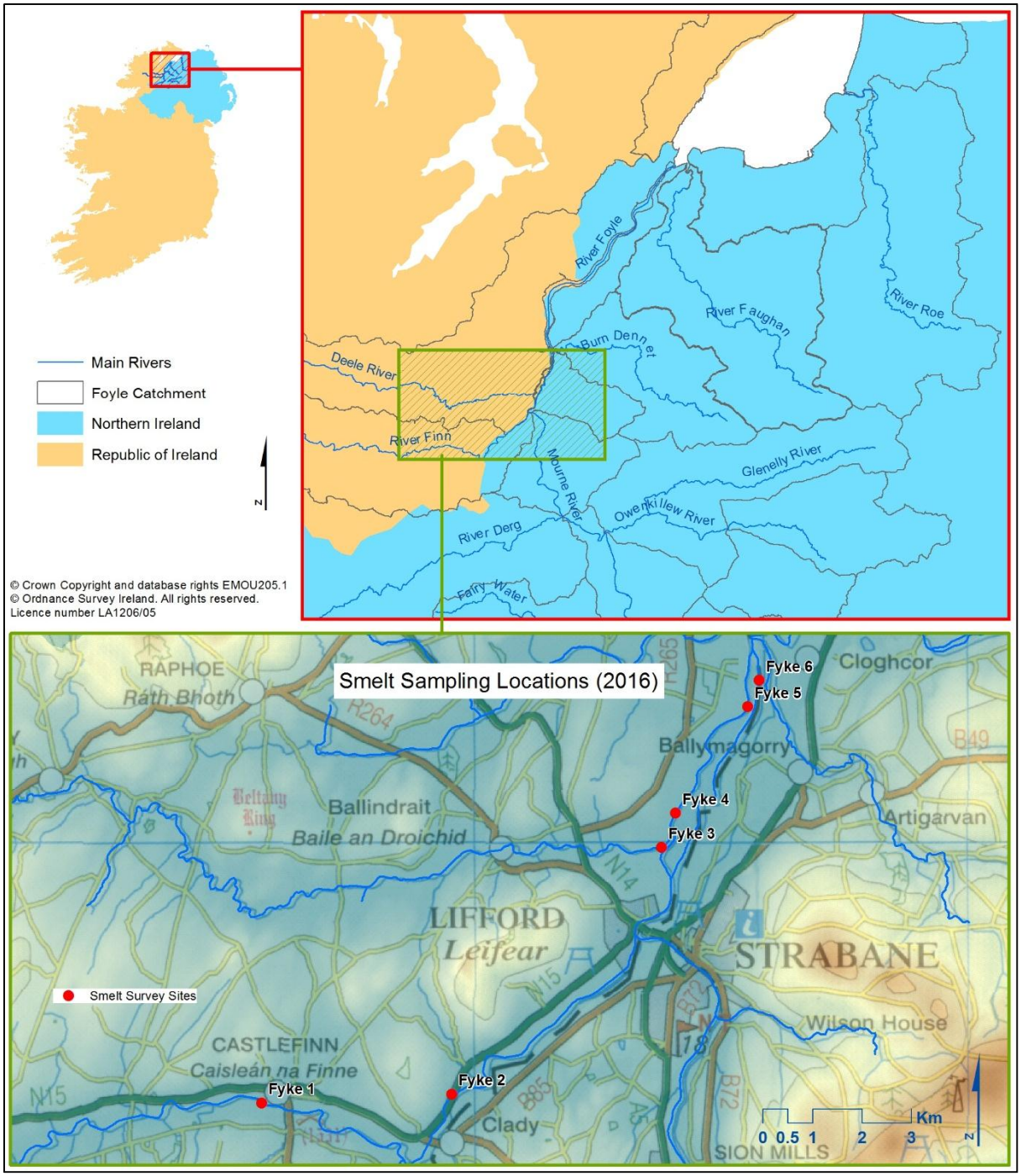

Fig 7. Map showing 2016 Smelt sampling locations on the River Finn, River Deele and River Foyle

A sub sample of Smelt caught in 2016 was analysed for age (including back calculated growth analysis), fecundity, gill raker counts and maturity stage. This work was conducted in collaboration with inland Fisheries Ireland. It is hoped this will contribute towards an all island paper on the ecology of Irish European smelt.

In 2017 a temporal study was conducted for the first time on the River Mourne. Three sets of fyke nets were deployed on the lower River Mourne in Strabane on the 14th March 2017. Fykes 2 and 3 only were deployed on the 24th March 2017 due to difficulty in locating suitable flow conditions at location 1.

Fig 8. 2016 survey locations on the River Mourne

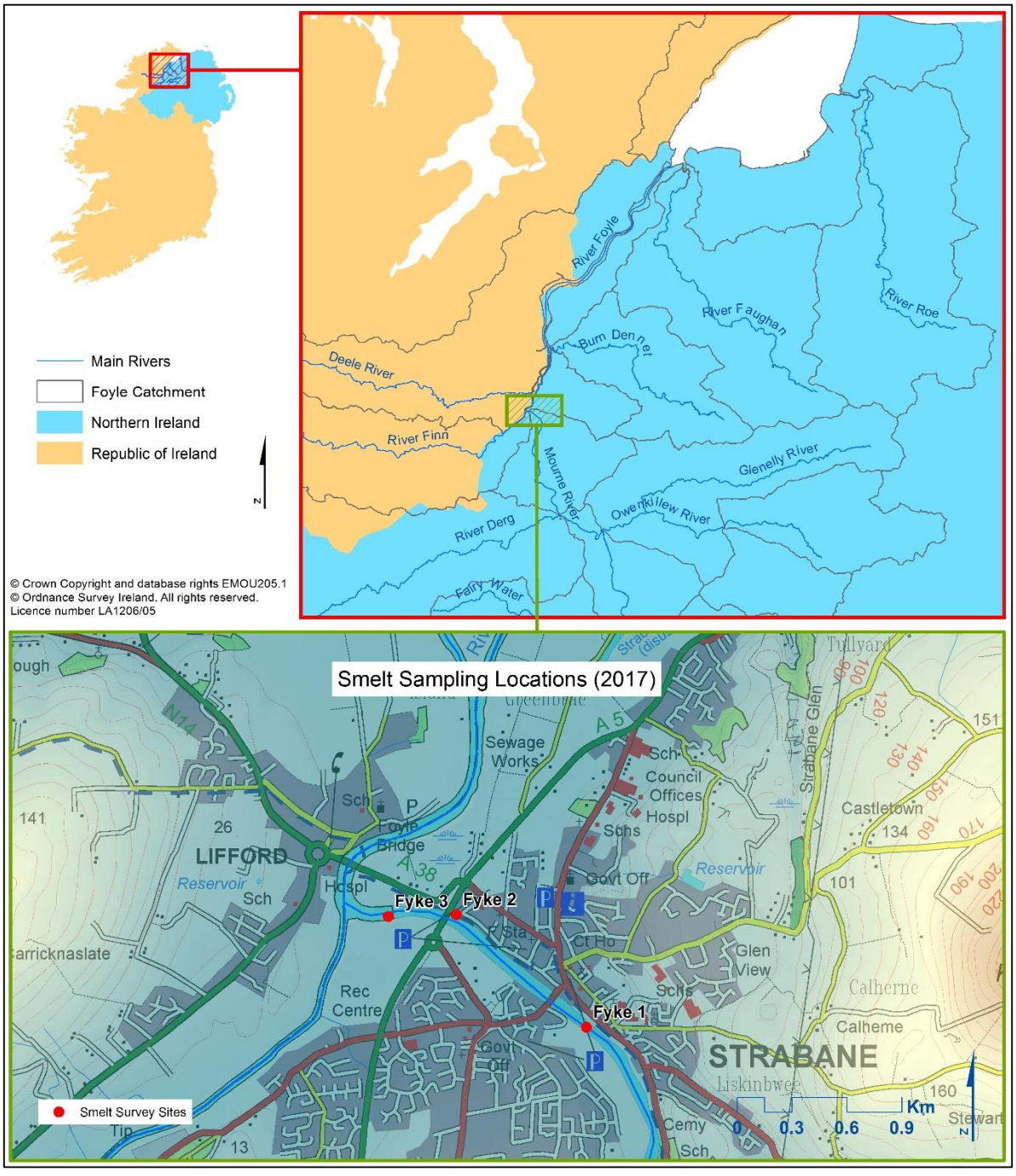

Fig 9. Map and picture showing 2017 Smelt sampling locations on the River Mourne

3.0 RESULTS

The first known records of spawning European smelt locations in the Foyle area were presented in the 2011 report (Niven, 2011). The River Finn, River Deele and River Foyle were all confirmed as locations for spawning European smelt. The 2011 report highlighted as a priority for further work the identification of other spawning locations in the Foyle area. The 2012 survey was designed to optimise the opportunity for recording European smelt at spawning time in the lower River Roe and lower River Faughan. Over the six week sampling period (once weekly sampling) no European smelt were encountered. A varied by catch was recorded and is presented in Table 2.

SPECIES	NUMBER
Brown Trout	1
Brown Trout parr	5
Eel	7
Flounder	91
Minnow	10
Salmon parr	14
Salmon smolt	6
Sea trout kelt	2
Sea trout smolt	19
Stickleback	4

Table 2. Species and numbers of by catch from River Roe and River Faughan, 2012.

Additional monitoring at Coolkeeragh Power Station water intake was also conducted between June and September 2012. 622 European smelt were recorded, the details of which are presented below.

YEAR	LOCATION	MIN LENGTH (cm)	MAX LENGTH (cm)	MIN WEIGHT (g)	MAX WEIGHT (g)
2012 (June to Sept)	River Foyle (Coolkeeragh)	4.5	23.5	0.3	91.1

Table 3. Coolkeeragh European smelt min and max lengths and weights June to Sept 2012

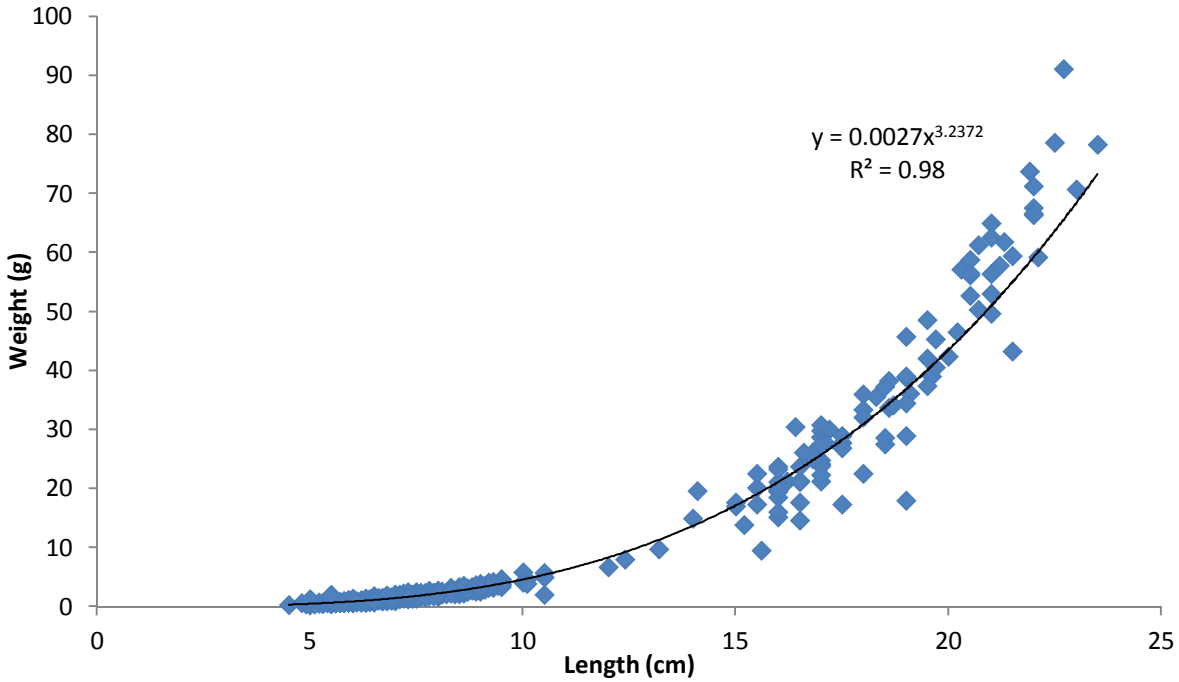

Fig 10. European smelt length weight relationship Coolkeeragh June to Sept 2012 n = 622

In 2016 surveys were carried out on four occasions during March and April. During the first sampling period on the 10th March, a total of six Fyke nets were deployed overnight. Fyke net 6 was deployed near the Geegle Bed on the Backwater of the River Foyle. On this occasion there were no Smelt caught in this Fyke net. At low tide the very top of this Fyke was also visible, therefore a decision was made to remove this sampling location from the remainder of the survey. Fyke net 1 on the River Finn was also removed after three sampling periods with no catch. Table 4 below shows the total number of smelt caught in each net over the six sampling periods in 2016.

NET ID	NUMBER OF TIMES DEPLOYED	NET LOCATION	NUMBER OF SMELT CAUGHT
FYK1	3	River Finn	0
FYK2	4	River Finn	8
FYK3	4	River Deele	23
FYK4	4	River Foyle	33
FYK5	4	River Foyle	49
FYK6	1	River Foyle	0
TOTAL			**113**

Table 4. Total number of smelt caught in each net over the six sampling periods, 2016.

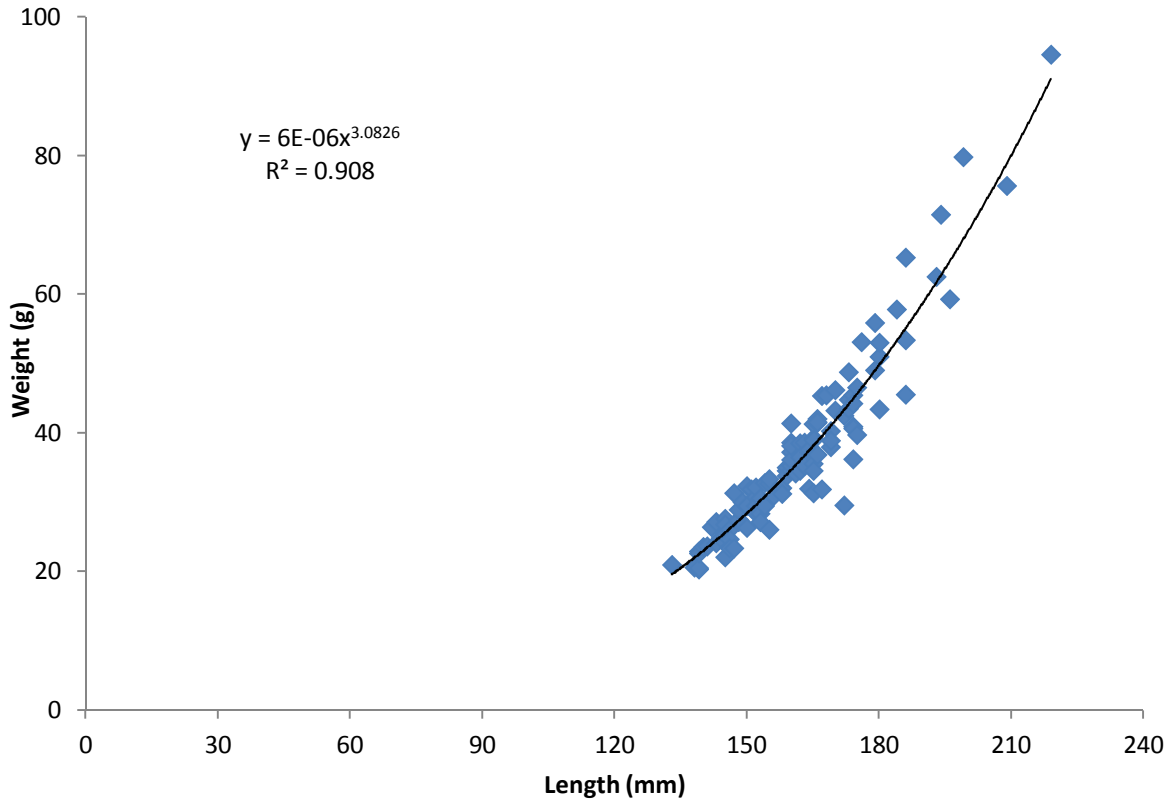

Fig 11. Length weight relationship of Smelt caught in 2016 (n=113)

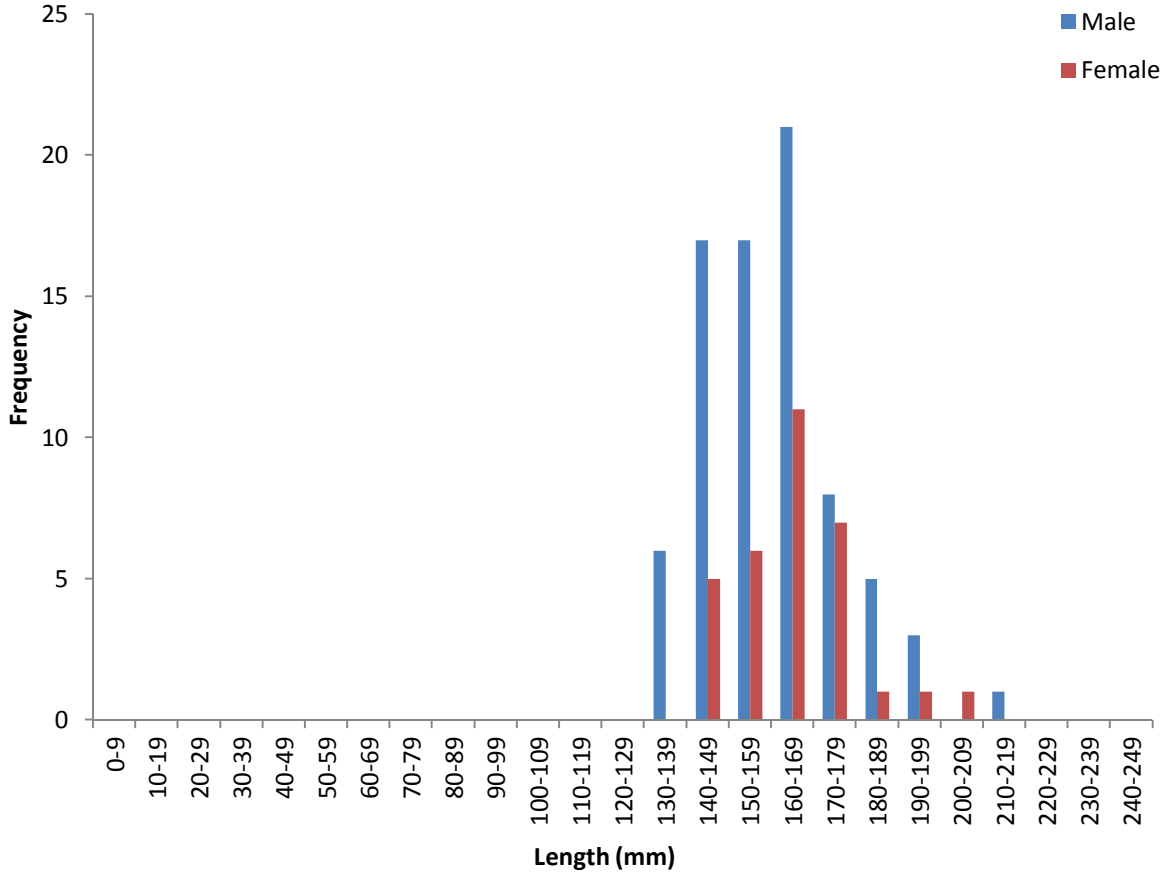

Fig 12. Length frequency of Smelt caught in 2016 (n=113)

The sex of each smelt caught was recorded on each date. Figure 13 below outlines the sex ratios for each sampling date in 2016. These sex ratios can be used to identify peak spawning time.

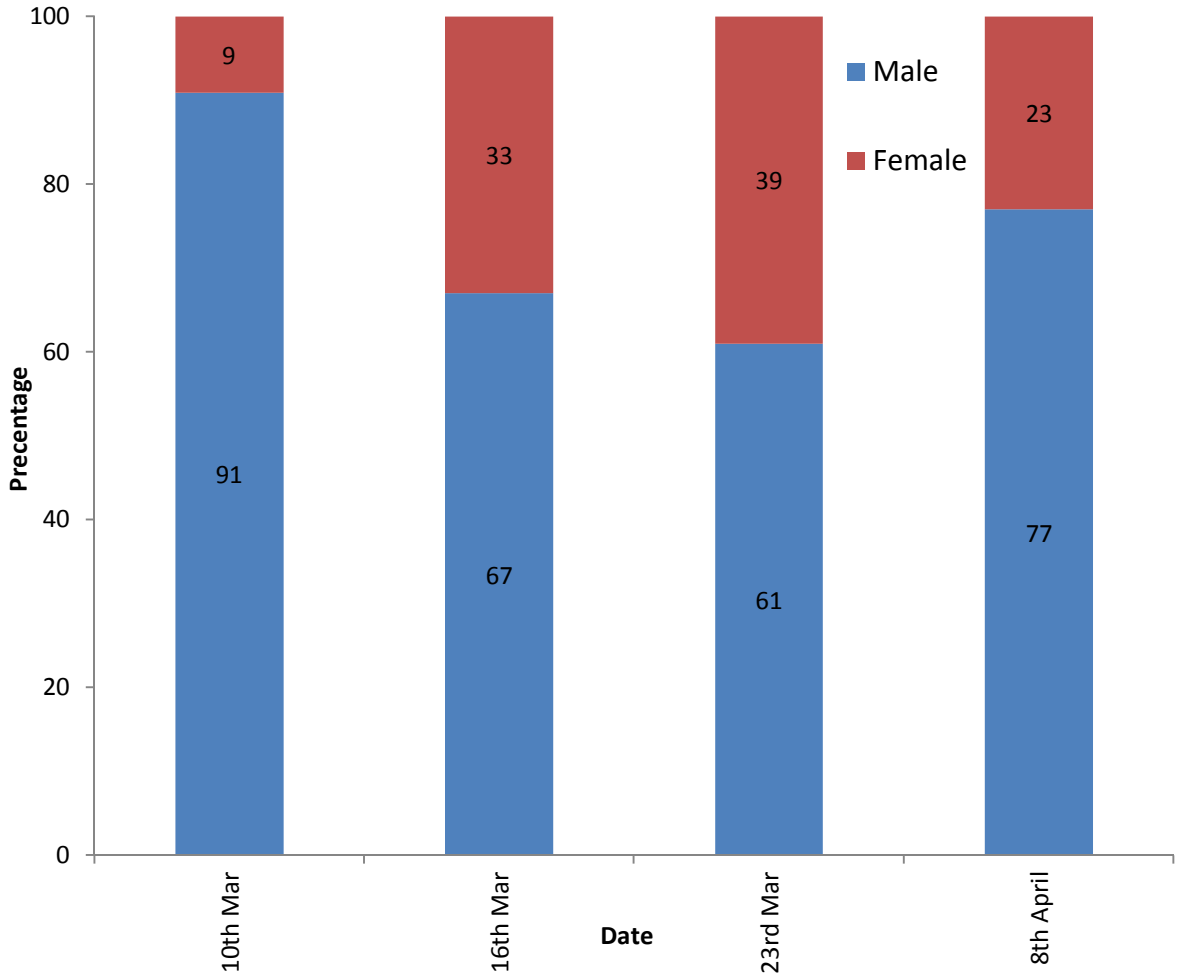

Fig 13. Sex ratios of smelt, 2016 (n=110)

SAMPLING PERIOD	SEX RATIO MALE:FEMALE (%)
10TH March 2016	91:9
16th March 2016	67:33
23rd March 2016	61:39
8th April 2016	77:23

Table 5. % Sex ratio of smelt caught in 2016 (10th March to 8th April 2016)

Scale samples were taken from a sub-sample of thirty six smelt for fish aging and back calculated growth analysis Figures 14 and 15 below show the percentage in each age class and the length at age for the sub sample.

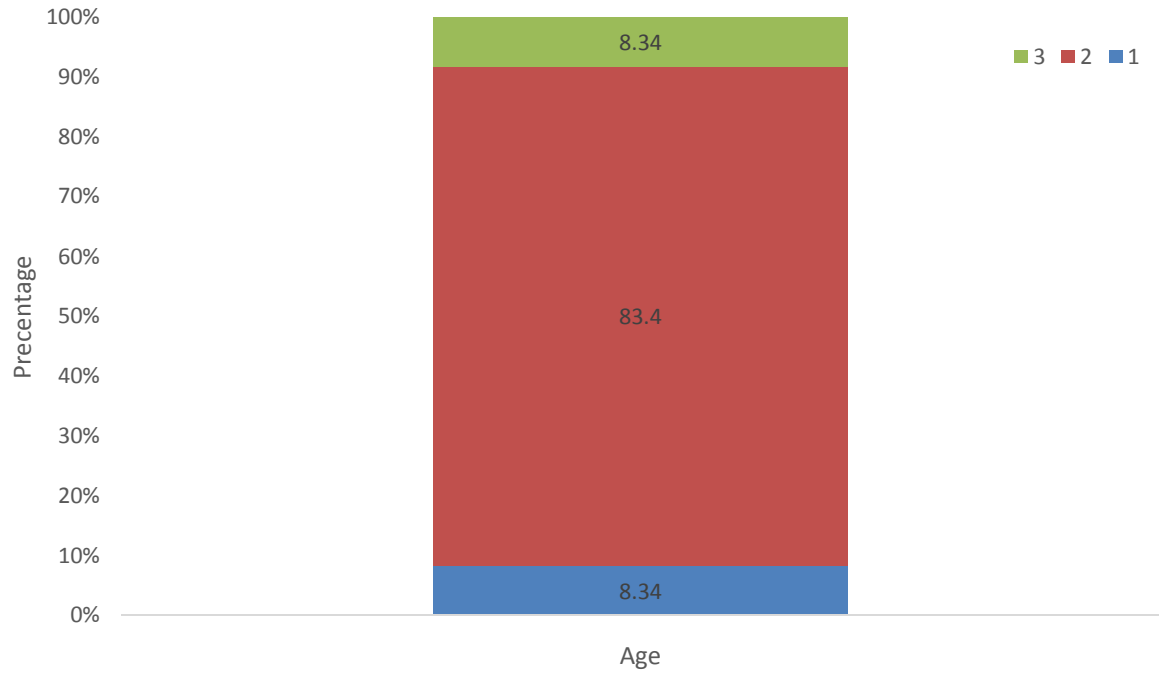

Fig 14. Percentage age class of Smelt, 2016 (n=36)

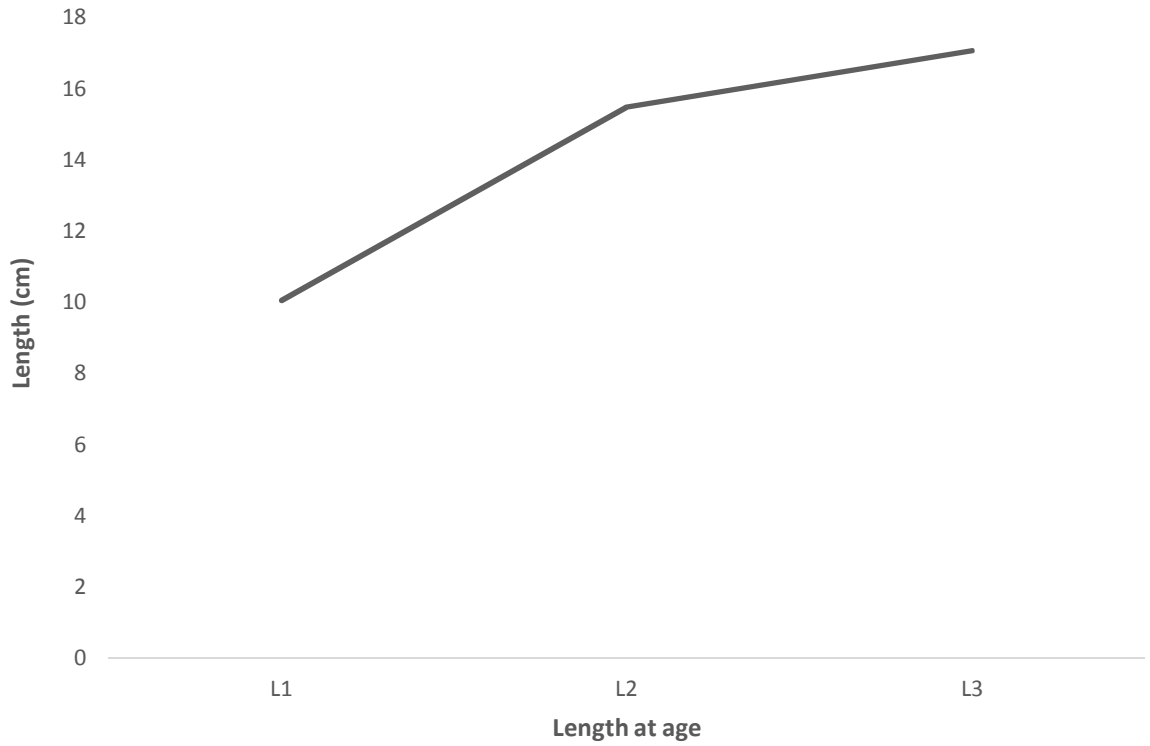

Fig 15. Back calculated growth analysis for smelt, 2016 n= 35

In 2017 over the two survey nights on the 14th March and 24th March, 151 smelt were caught. All smelt in the survey were caught on 14th March. Table 6 shows the number of smelt caught in each net on 14th March.

NET ID	NET LOCATION	NO OF SMELT CAUGHT
FYK1	River Mourne	0
FYK2	River Mourne	96
FYK3	River Mourne	55

Table 6. Total number of smelt caught in each net, 14th March 2017 (n=151)

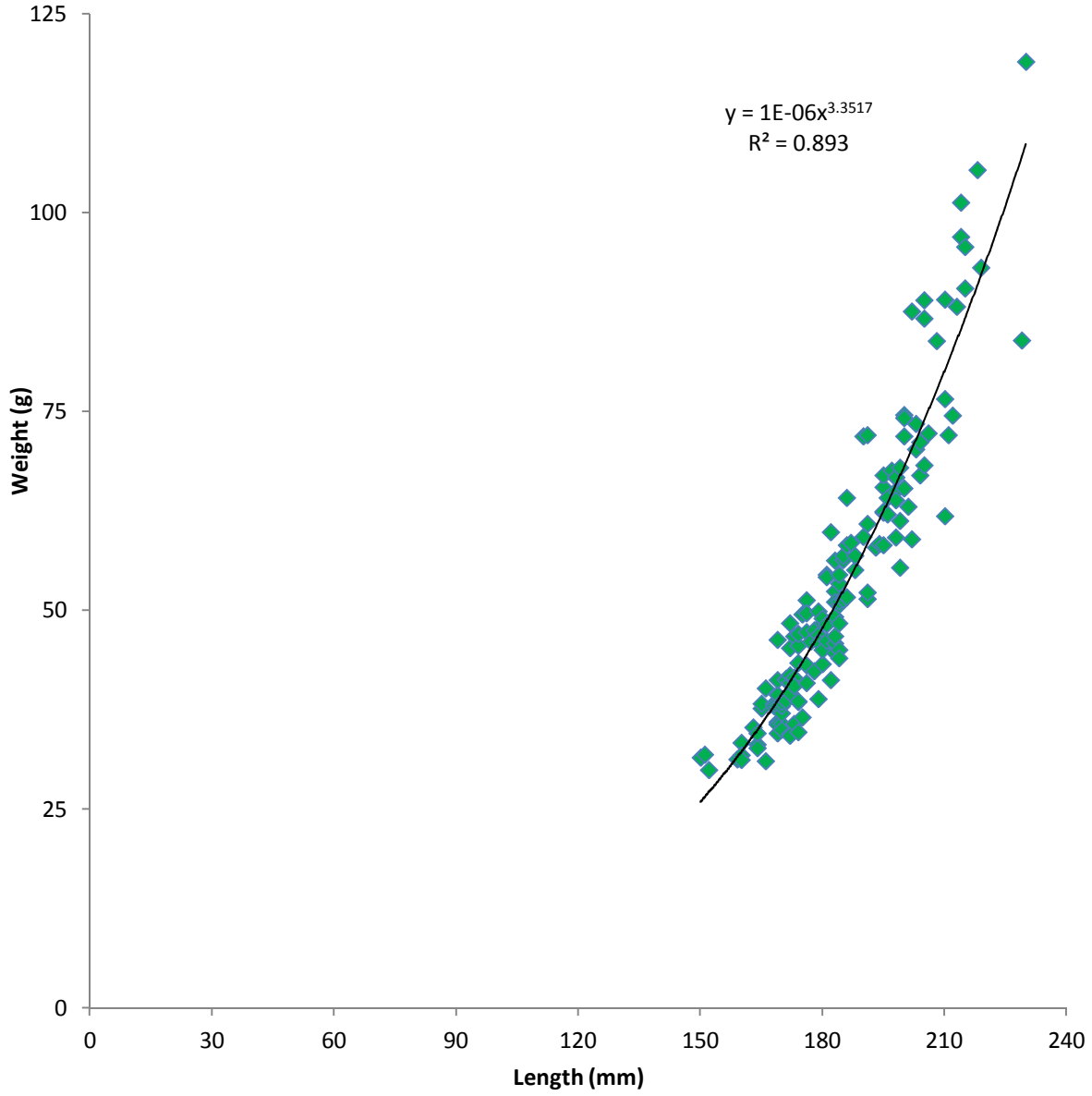

Fig 16 Length weight relationship of smelt, 2017 (n=151)

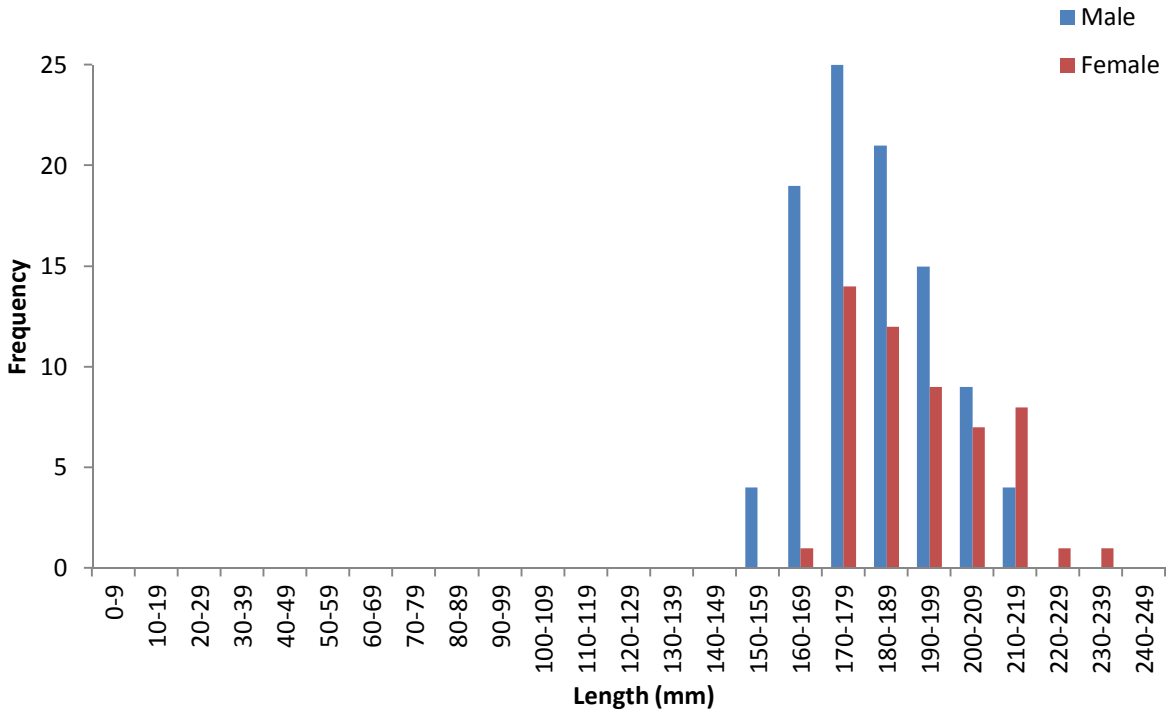

Fig 17 Length frequency of smelt, 2017 (n=151)

Sex ratios were recorded again in 2017 and suggest that peak spawning was close to the 14th March. No smelt were caught on the 24th March.

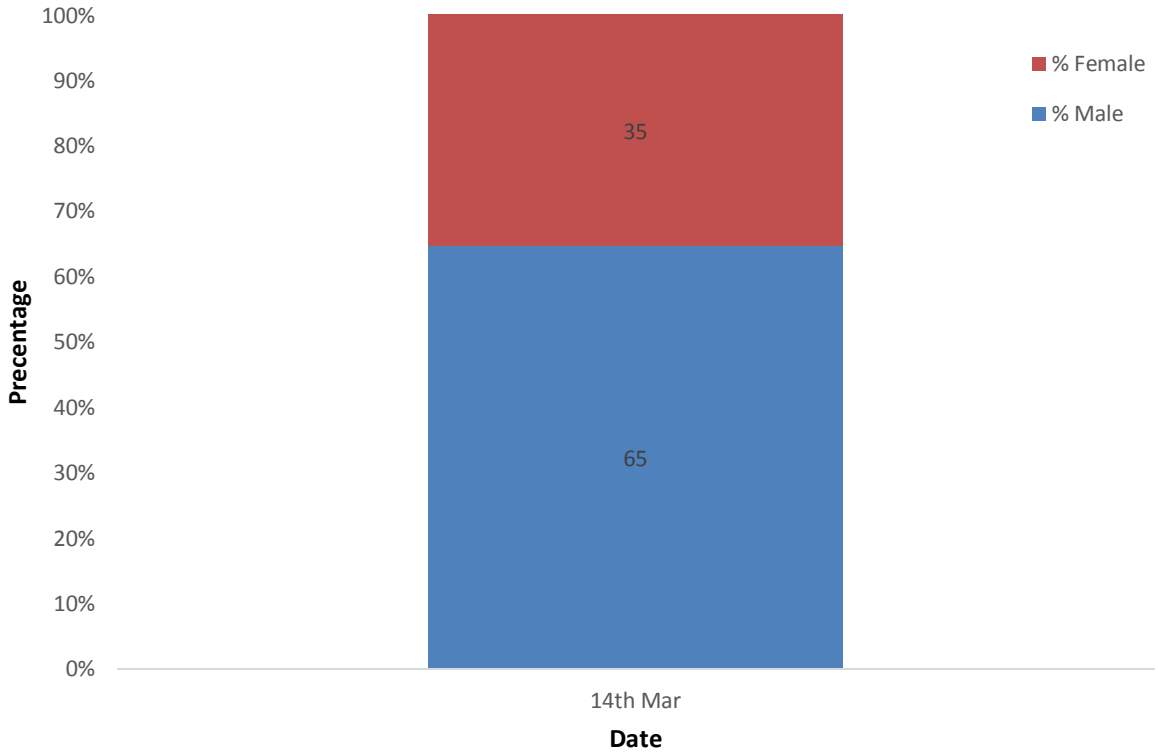

Fig 18 Sex ratio of smelt, 14th March 2017 (n=150)

YEAR	RIVER NAME	MEAN LENGTH (cm)	MEAN WEIGHT (g)	SAMPLE SIZE
2010	River Finn	17.61	N/A	49
2010	River Deele	17.99	N/A	9
2010	River Foyle	17.47	N/A	70
2010	Combined	17.60	N/A	128
2016	River Finn	16.40	37.43	8
2016	River Deele	16.20	37.10	23
2016	River Foyle	16.20	36.94	82
2016	Combined	16.20	37.00	113
2017	River Mourne	18.5	53.96	151

Table 7. Summary data from Foyle area European smelt adult spawning surveys 2010 to 2017

Additional biological information on fecundity, gill raker counts and maturity has been collected and will be presented in a separate publication.

Fig 19. European smelt fecundity analysis

Fig 20. European smelt gill raker from the 1st gill arch

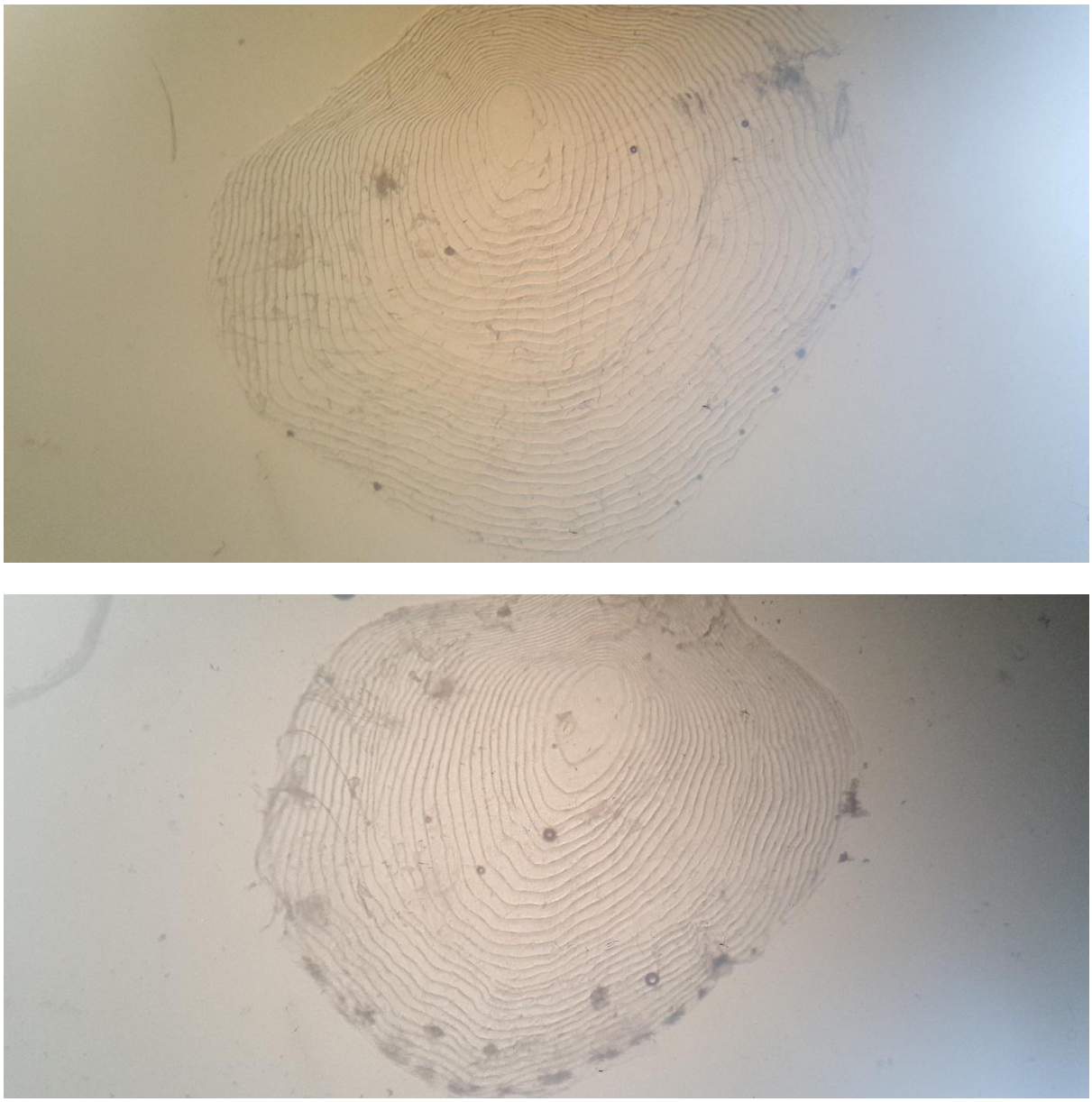

Fig 21. European smelt scales

4.0 DISCUSSION

After extensive targeted Smelt surveys on the River Faughan and the River Roe in 2012 no smelt were encountered. This would suggest that smelt from Lough Foyle at present use the River Foyle and its tributaries for spawning. European smelt have been caught in the Roe and Faughan estuaries in other surveys but not at spawning time. Smelt may use the Roe and Faughan estuary areas for feeding purposes. At some stage in the past there may have been a spawning population in the Faughan and Roe although no information could be found to confirm or reject this possibility. In the future a spawning population may establish. A follow up survey every five years or so could monitor this situation.

The 2016 survey showed European smelt have continued to use the River Foyle and its tributaries, the Finn and the Deele, for spawning. Smelt were encountered in both tributaries of the Foyle, the River Finn and River Deele, albeit in much smaller numbers than encountered in the River Foyle. Sex ratios and temporal samples have facilitated a better understanding of peak spawning time and significant biological information collected and analysed for use in comparative studies across the island of Ireland and elsewhere.

The March 2017 survey was carried out to determine if a spawning population of European smelt was present within the River Mourne. Fyke nets 2 and 3 on the River Mourne just above the confluence with the River Foyle captured 96 and 55 Smelt respectively. Appropriate spawning habitat is present in both locations and follow up surveys should be conducted to confirm if these are being actively utilised. Fyke net 1 failed to capture any smelt during the survey period which could suggest the net was above the upper limits of the Smelt spawning location. All 151 smelt caught in the 2017 survey were captured in the first survey period of 14th March. The next survey time of 24th of March failed to capture any smelt. This could be due to the spawning of smelt having finished and all individuals having returned downstream. Additional temporal surveys within the Mourne catchment are recommended. Timing of European smelt spawning is known to occur in early March however it can vary depending on external factors such as tides and water temperature.

The sex ratios of a population of smelt in freshwater can be used to determine the peak spawning time. Typically males enter freshwater prior to females with

numbers of females only rising close to peak spawning time. By looking at the ratio of females to males in freshwater over a temporal scale it is possible to estimate the spawning time when the ratio of males to females is closest to equal. In 2016 the closest to equal ratio was encountered on the 23rd March with 61% of the catch being male and 39% being female. This would suggest spawning occurred sometime between 16th March and 8th April around the 23rd March. An intensive survey for a fortnight could be carried out around this time on the River Foyle to determine precisely when the sex ratio is closest to equal and as a result clearly identify precise spawning time and locations. A fuller understanding of this will facilitate more appropriate conservation and protection action and ensure protection of critical spawning habitats.

Sand and gravel extraction operations are conducted within areas known to be inhabited by spawning smelt on the River Foyle. Urgent action is required to appropriately control this industrial scale extraction.

5.0 INVASIVE SPECIES

Invasive non-native species are those which have been transported outside of their natural range. They are capable of spreading rapidly and colonising a wide range of habitats. They also exhibit competitive dominance by out-competing native flora and fauna for light, oxygen and food. There is growing evidence to suggest that invasive riparian plants are having an adverse effect on aquatic habitats and species by altering both in-stream processes and terrestrial-aquatic linkages. Invasive species threaten native species as direct predators or competitors, as vectors of disease, and by modifying the native habitats. Invasive species are considered the second biggest threat after habitat loss to biodiversity worldwide by the Millennium Ecosystem Assessment in 2005.

Water is an excellent transport medium for the dispersion of many of these species. Rivers and loughs with their banks and shorelines are amongst the most vulnerable areas to their introduction, spread and impact. The focus for the Loughs Agency is predominantly on aquatic and riparian invasive species as these are a serious threat to our sensitive aquatic habitats. The spread of invasive species can also further threaten already endangered native species. In freshwater habitats the introduction of invasive species is considered the second leading cause of species extinctions. Invasive species are a global

problem and once they are established eradication is often costly and extremely difficult. Previous studies suggest that early intervention is a more successful and cost-effective way of preventing the spread of invasive species.

There are a multitude of invasive non-native species across the UK and Ireland at present, many of them with the potential to cause serious environmental harm. Three species in particular, Japanese Knotweed (*Fallopia japonica*), Himalayan Balsam (*Impatiens grandulifera*) and Giant Hogweed (*Heracleum mantegazzianum*) have become an established threat to the streams and rivers of the Foyle and Carlingford areas. Rivers are an excellent means of transporting, dispersing and spreading invasive species, therefore it is no great surprise to see a proliferation along our river corridors.

There is a growing body of evidence demonstrating the damaging impacts of (INNS) invasive non-native species. The problem of excessive soil erosion along the riparian zone can have grave consequences for freshwater fish species. Atlantic salmon (Salmo salar) and Trout (Salmo trutta) are reliant upon finding appropriately sized spawning gravel to complete their life cycle. However, Himalayan Balsam will die back in winter time, leaving behind exposed river banks devoid of any natural vegetation. The lack of vegetation on the riparian zone leaves the bank highly susceptible to soil erosion at times of increases flows and floods. Excessive soil erosion will increase the sediment load into the stream reach and can potentially smother the eggs buried in the spawning gravel, starving them of oxygen. Atlantic salmon stocks are at unprecedented low levels and they are also experiencing very high mortality rates during the marine phase of their life cycle. Increased sediment being introduced to rivers and streams has the potential to diminish juvenile abundance even further and merely exacerbates the problem still further.

6.0 BIOSECURITY

Invasive species are an ever present threat in our aquatic and riparian systems and it is imperative that none of our field operations exacerbate the risks to the environment and to the economy that are posed by these species. Fish parasites, pathogens and diseases also represent a significant threat to the health status of our watercourses. The introduction or transfer of such pathogens or diseases

has the potential to wipe out large populations of fish in affected waters or catchments. Loughs Agency staff are required to be vigilant to help prevent the spread of fish diseases and invasive species. The agency has incorporated biosecurity protocols into its freshwater fisheries monitoring programme and these guidelines are also adhered to by fishery officers and field staff alike. The Loughs Agency biosecurity protocol for field operations was fully implemented during the Foyle Smelt surveys.

7.0 CONCLUSION

European smelt are an important part of the native fisheries biodiversity of the Foyle area and indeed the island of Ireland. At certain times and to certain audiences it can be an abstract concept that a species with no commercial or recreational value should be afforded conservation and protection efforts. Yet over recent years the concept of ecosystem services and quantifying the economic value of the environment can and is being calculated and analysed. Without too much effort direct links can be made between European smelt and more traditional economically significant species such as Sea trout and Atlantic salmon. European smelt play an important role in the ecosystem of Lough Foyle and the rivers which discharge into it. European smelt are an important prey item for numerous fish species of commercial and recreational interest that inhabit Lough Foyle utilising the productive waters as spawning, nursery and feeding territories for some or all of their lives. Without fully understanding the biology and ecology of a species such as the European smelt essential spawning and nursery habitats can be destroyed or removed with unknown side effects. Lough Foyle, its primary tributary rivers and the organisms that move around them form an interdependent ecosystem that provides numerous as yet not fully understood or quantified services from cleaning water, to sequestering carbon to supplying sources of both food and water amongst other essential services. Failure to appropriately consider this series of connected ecosystems will lead to further degradation of these internationally important habitats and species and delay the restoration efforts that are being implemented in other similar habitats throughout the world.

It is for these reasons that concerted conservation and protection actions informed by evidence collected through considered monitoring programmes

like the monitoring of European smelt populations will inform the development of appropriate legislation and regulation.

8.0 RECOMENDATIONS

- Continue to conduct European smelt monitoring within the Foyle and Carlingford areas at appropriate spatial and temporal resolution to confirm exact spawning locations and to monitor stock status.

- Conduct post spawning egg surveys on the moss covered flood walls on the River Mourne and other known spawning sites.

- Repeat survey on River Roe and River Faughan to conclusively rule out a spawning population of smelt in either river.

- The establishment of local “Areas of Environmental Concern” should be considered within the Foyle area.

- Developing conservation partnerships and environmental education and outreach programmes to raise awareness of the European smelt and potential threats to it within the Foyle area.

- Urgent action is required to appropriately control industrial scale sand and gravel extraction from the River Foyle in known Smelt spawning areas.

9.0 REFERENCES

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