Newport Research Facility

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Report for the year ended 31st December 2017

This report follows in sequence from the Annual Reports of the Salmon Research Agency of Ireland Inc. and the Salmon Research Trust of Ireland Inc.

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Summary

1. The Salmon Research Agency of Ireland merged with the Marine Institute on the 1st July 1999 into Aquaculture & Catchment Management Services and in 2010 the group merged with Fisheries Ecosystem Advisory Services. This report provides a continuation of the data records for the Burrishoole facilities.

2. The total rainfall recorded in Furnace in 2017 was 1731.0 mm. Rainfall in 2017 was above average, but not unusually so. Of note was the low amount of rain in January and from April to June. Months of relatively high rainfall were February, March and from July to December. Low rainfall was recorded in January, April, May and June.

3. The environmental programme was maintained in the catchment with the network of rain gauges, water level recorders and river and lake monitoring stations all in operation. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites. In the last two decades, the physical, chemical and meteorological data have been supplemented with biological datasets describing zooplankton and phytoplankton assemblages in Lough Feeagh and Lough Furnace, along with macroinvertebrate species occurrence and abundance from 16 index sites.

4. The total release of microtagged smolts of ranched Burrishoole grilse origin was 33,304 comprising of 6 tag codes. On 27th April 2017, three tag groups (14,925) were released into Lough Furnace and one group (3,673) was released into the estuary at Burrishoole Abbey. Further releases into Lough Furnace took place on 4th May 2017 (7,486) and 12th May (7,220) to coincide with releases of acoustically tagged wild and ranch smolts. Conditions at release were unusual following several weeks of dry conditions. Water levels in Lough Feeagh were low, restricting the movement of wild salmon smolts, and surface salinity in Lough Furnace ranged 11-14 ppt.

5. In 2007, the Irish Government introduced a cessation of drift netting for salmon at sea and this was continued in 2017.

6. A total of 529 wild grilse and 3 previously spawned grilse (psg) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded was 9. The total run of wild grilse, including the Furnace rod catch (0), was 529 + 3 previously spawned grilse as determined by floy tag returns.

7. Four escaped farm fish were recorded in the upstream traps in 2017 and these were culled.

8. No pink salmon were recorded in 2017, although one specimen was retrieved by an angler in the nearby Owengarve River.

9. Returning adults were checked for net mark damage; 1.9% (n=526) of wild salmon (mainly in July) and 3.97% (n=1083) of reared salmon (in June, July and August) had net marks present.

10. The maximum spawning escapement was estimated to be 478 wild (following removal of 30 fish for broodstock) and 52 reared fish.

11. A total of 5029 wild salmon smolts were recorded in the downstream trap in 2017. The wild return of 2016 smolts as wild grilse in 2017 was 7.4%, another slight drop from the 7.8% in 2016. The ova to smolt survival at 0.46 - 0.52%.

12. Wild kelt survival was 42.1% and the tagged kelt return in 2017 as previously spawned grilse later in the year was 1.6%.

13. The percentage return for reared grilse ranged from 3.3% to 3.6%. The lower return was from a group released at Burrishoole Abbey. A relase of smolts into L Feeagh gave a 2.9% as grilse from release, or 3.5% return from the survivors passing through the trap.

14. A total of 10 wild sea trout and a further 53 non-silvered trout migrated upstream through the traps in 2017. Of the silvered trout, 2 were adults and 8 (80%) were finnock.

15. The 2017 sea trout smolt run amounted to 291 smolts.

16. The percentage of trout smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1989 it collapsed to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's between 4 & 10%, rising to 16.7% in 1999. Finnock return in 2017 was 2.8%.

17. Silver eel trapping continued with the total run amounting to 2210. In 2017, the timing of the run was 15% migrating in August, 31% in September and 40% in October (Table 7.1). 90% of the run was completed by the end of October.

18. A total of 69 salmon were caught in the Rod Fishery in 2017. The catch consisted of 12 wild fish and 57 reared salmon. No wild fish were killed. All fish were caught on Furnace as L. Feeagh was closed to angling in 2017. A total of 6 sea trout were caught on Lough Furnace. Regulations remained in place whereby all rod caught sea trout were returned alive.

19. 2017 marked the completion of 27 years of catchment electrofishing surveys for juvenile salmonids and eel and beach seine surveys of the lakes for juvenile salmonids.

20. Eel fyke net surveys of Bunaveela, Feeagh and Furnace were undertaken in 2017 and quantitative enclosure net surveys were also conducted.

21. *Anguillicola crassus*, the non-native swim bladder parasite of eel, was recorded in the saline waters of Lough Furnace for the first time in 2011 and each year since. Infection intensity increased year on year but fell in 2016. This is the first known introduction of an aquatic invasive species into Burrishoole. In 2016, 28 silver eels were checked and 10 were found to be infected with adult worms (35.7%) at an intensity of 2.0% - this was the first recorded incidence of *A. crassus* from above the traps in freshwater in Burrishoole. In 2017, the prevalence was 66.7 in Feeagh yellow eel, 66.7 in Furnace yellow eel and 65.4 in silver eel and the intensities were the highest recorded to date at all sites.

22. Staff in Newport were authors on nine peer-review publications and were involved with eight reports in 2017, including seven ICES Working Group reports.

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1 Introduction

This report represents a continuation of the scientific aspects of the Annual Reports published by the Salmon Research Agency of Ireland, now integrated into the Fisheries Ecosystem Advisory Services Group (FEAS) of the Marine Institute. The data presented creates a unique record of fish rearing and wild fish census data for the past 47 years. This data is an essential component in the local, regional and national management of salmon, sea trout and eel and is becoming ever more valuable in the light of increasing pressures on natural stocks, such as exploitation, habitat degradation and global climate change scenarios. The fish monitoring facilities in Newport, along with the reared and ranched salmon stocks held in Burrishoole, are also essential for supporting projects such as development of novel enhancement techniques, alternative stocks and ranching and evaluation of interactions between farmed, ranched and wild strains. An expanding programme in the Burrishoole system is including ecological and genetics research into eel, sticklebacks and stock dynamics of juvenile salmonids and eels.

2 Environmental Data

2.1 Mill Race Data

2.1.1 Rainfall

Daily meteorological data were collected during 2017 at the manual Met Station in Furnace. The monthly rainfall figures for 2014, 2015, 2016 and 2017 are given in Table 2.1, along with the annual totals for the years 1977 to 2017. Rainfall in 2017 was above average, but not unusually so. Of note was the low amount of rain in January and from April to June.

Months of relatively high rainfall in were February, March and from July to December. Low rainfall was recorded in January, April, May and June. The total rainfall was 1731mm in 2017. Daily rainfall amounts are shown in Figure 2.1.

Table 2-1: Monthly rainfall totals (mm) for the Furnace Station in 2014, 2015, 2016 and 2017 and the annual totals for 1977 to 2017.

Month	2014	2015	2016	2017	Year	Total	Year	Total
January	295.9	257.4	186.2	87.70	1977	1579.7	2000	1833.2
February	252.7	148.9	214.1	157.70	1978	1592.2	2001	1298.7
March	125.3	150.0	139.5	225.80	1979	1653.3	2002	1715.9
April	52.1	123.5	96.5	25.30	1980	1792.1	2003	1353.2
May	131.7	161.1	49.35	63.10	1981	1646.8	2004	1641.3
June	60.9	49.8	102.4	98.80	1982	1609.6	2005	1608.2
July	87.7	152.3	100.7	181.70	1983	1495.9	2006	1550.7
August	116.0	114.0	132	186.25	1984	1556.6	2007	1576.8
September	15.4	155.8	196.1	146.80	1985	1584.1	2008	1805.0
October	158.8	85.3	41.3	169.60	1986	1886.9	2009	1793.9
November	134.6	335.4	160	206.95	1987	1373.6	2010	1311.6
December	292.0	278.4	96.3	181.30	1988	1715.2	2011	1826.9
					1989	1583.9	2012	1676.4
Total	1723.1	2011.8	1514.5	1731.0	1990	1805.9	2013	1391.8
					1991	1549.6	2014	1723.1
					1992	1771.1	2015	2011.8
					1993	1473.4	2016	1514.5
					1994	1757.1	2017	1731.0
					1995	1382.5		
					1996	1286.6		
					1997	1351.6		
					1998	1830.9		
					1999	1949.1		

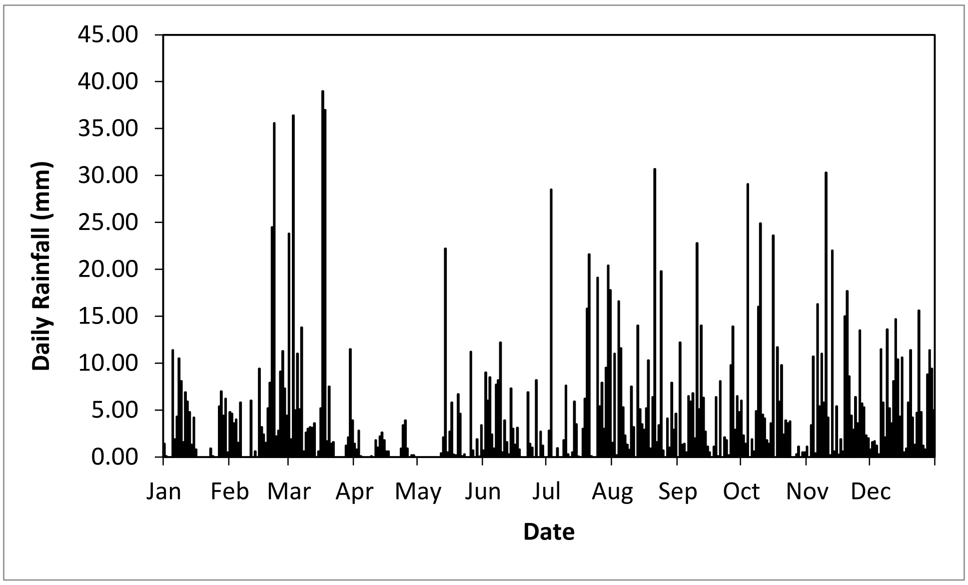

Figure 2-1: Daily rainfall amounts (mm) recorded in the Mill Race manual weather station in 2017.

2.1.2 Water Level and Temperature

Water Level: Difficulties were experienced in 2003 with the automatic water level chart recorder which had been in place since before 1970. An OTT Orphimedes automatic water level recorder was installed in late January 2004 and data from this sensor are presented here. Water levels are recorded every 15 minutes and are presented in Figure 2.2 recorded at 00:00 hrs.

The plot in Figure 2.2 shows a number of periods of low water, with drought periods through July, August, October, November and December. The year (especially the last quarter) was characterised by relatively steady water conditions and no large floods. There was one large flood in March.

Water Temperature: In 2004, a TidbiT temperature logger was installed along with the chart recorder and this records water temperature every 30 minutes. In 2009, this was upgraded to an OTT Orpheus mini sensor and logger. The temperature logger data are presented in Figure 2.3, recorded at midnight.

In 2017, water temperatures (recorded at midnight) fell to a minimum of 5.7^{0}C in February. There was then a fairly steady increase in temperature until a short cold snap at the end of April followed by a rapid warm spell in May to a peak of 15.5^{0}C and then a further warming to a peak of 17.4^{0}C in mid July before generally falling from the end of August through to the year end.

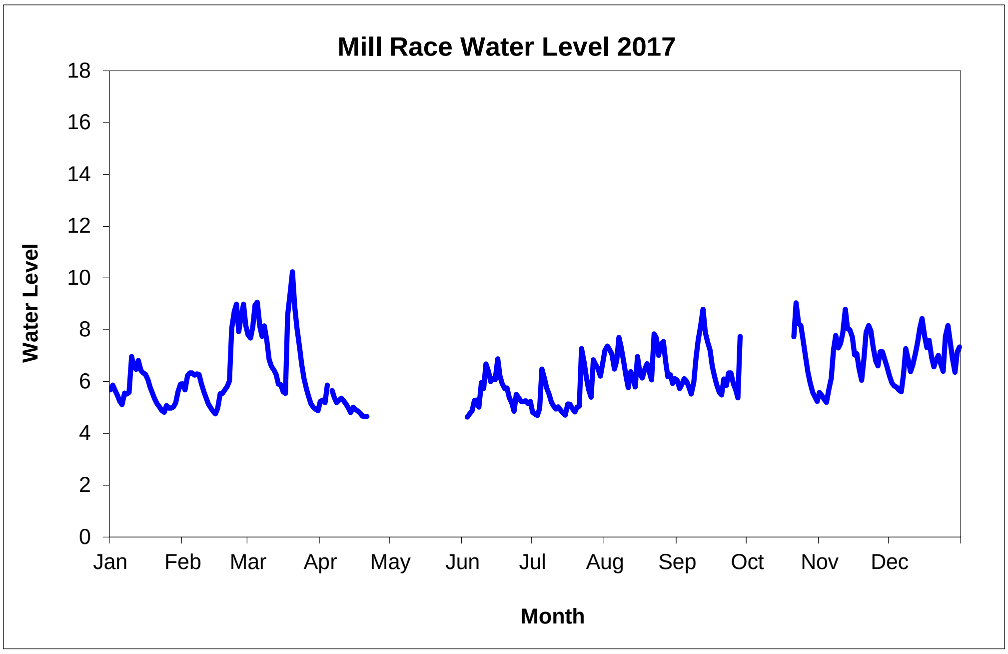

Figure 2-2: Water levels recorded at mid-night for the Mill Race using an OTT Orphimedes automatic water level recorder, 2017.

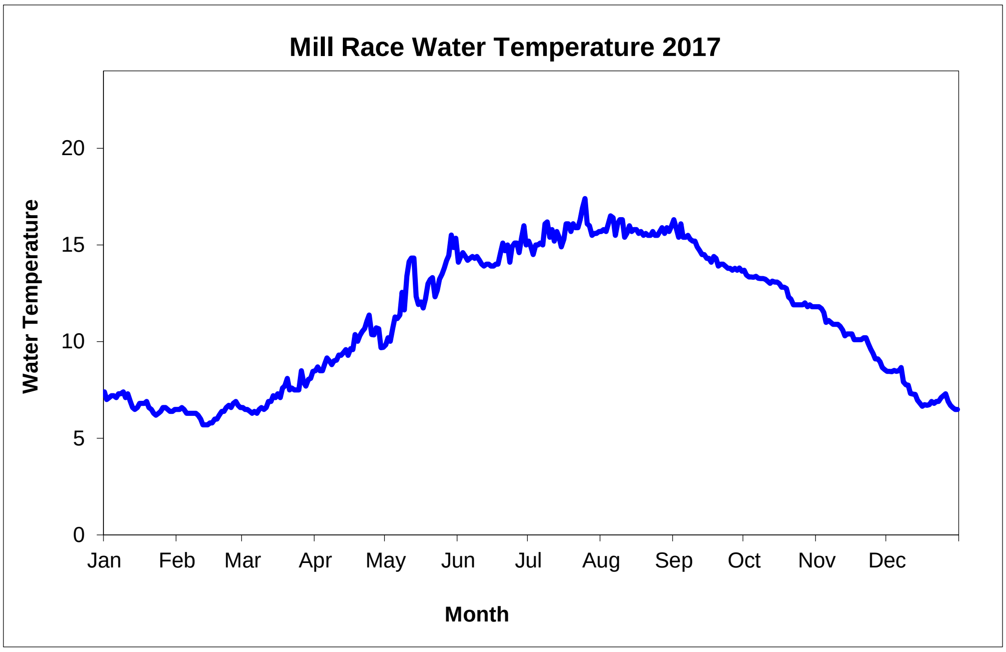

Figure 2-3: Water temperatures (°C) recorded, by OTT Orpheus mini sensor and logger, at mid-night for the Mill Race; some missing data infilled from a TidBit.

2.2 Catchment Programme

2.2.1 Background

Over the last twenty-five years, the Marine Institute has developed a monitoring programme in the Burrishoole catchment, with the aim of ensuring a long term ecological record against which changes in fish biology can be assessed. At the centre of the monitoring program are a series of automatic monitoring stations which measure key aquatic parameters at high frequency. These automatic stations include two lake stations (AWQMS), which have various meteorological instruments included with a suite of underwater temperature and water chemistry sensors, and three river stations, (ARMS), which are equipped with sensors for measuring water temperature, water level, pH, conductivity, dissolved oxygen, and turbidity. The automatic monitoring stations are also equipped with telemetry systems for relaying high-resolution data back to the laboratory. In 2016, we also instrumented the Mill Race with three platinum resistance thermistors (PRTs), a nephelometer (a proxy for turbidity) and a CDOM fluorometer (chromophoric dissolved organic matter). The data from the lake and river stations are complemented by spot samples analysed for water colour, turbidity, Total Phosphorus, Total Nitrogen and ethanol extracted chlorophyll *a*. In addition, the Institute maintains temperature loggers, water level recorders and data-logging rain gauges in the Burrishoole, Owengarve and Owenduff catchments. These instruments allow high-resolution patterns of rainfall to be linked with stream flow. An important feature of the monitoring network is the ability to collect simultaneous data from river, lake, and climatic instruments.

The physical, chemical and meteorological data have been supplemented with biological datasets describing zooplankton and phytoplankton assemblages in Lough Feeagh (since 2003) and Lough Furnace (since 2009), along with macroinvertebrate species occurrence and abundance from 16 index sites (since 2003).

2.2.2 The 2017 Programme

The maintenance and development of long term physical, chemical and biological datasets characterising the freshwater component of the Burrishoole catchment continued in 2017. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites.

2.2.3 The Black River

The main river flowing into Lough Feeagh is the Black River, also known as the Shramore River. A water level recorder is situated approximately 500m above the lake. Figure 2.4 shows the average daily water level for 2017 and Figure 2.5 shows the average monthly water levels from 2002 to 2017.

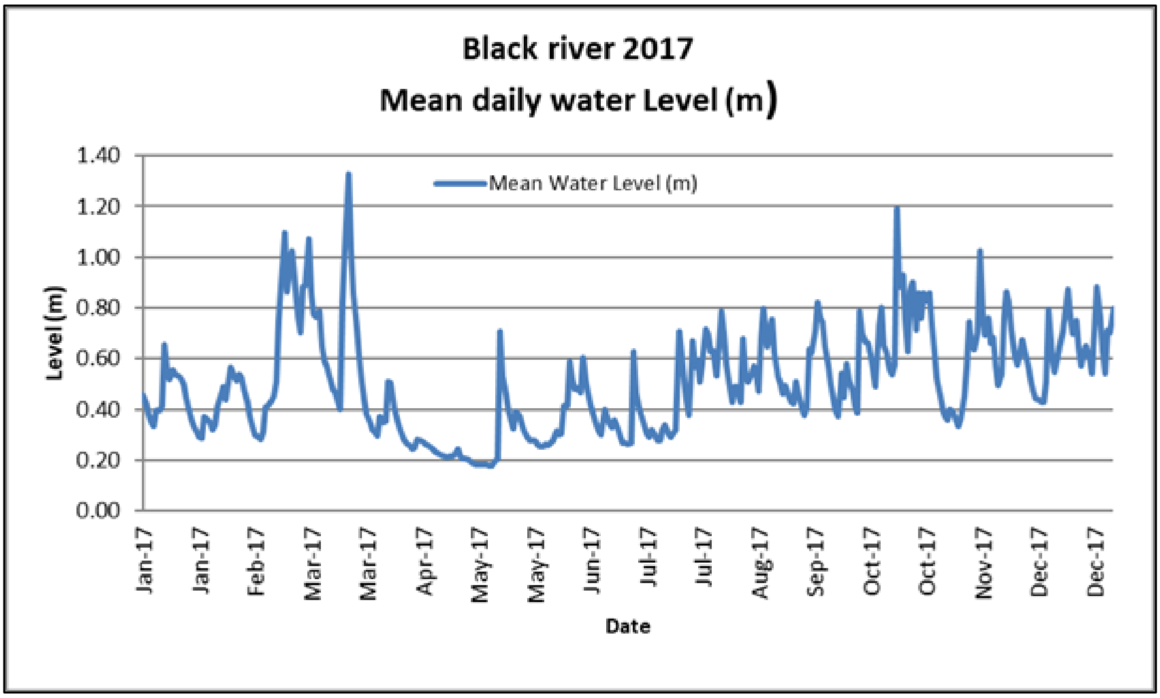

Figure 2-4: Mean daily water level for the Black River, 2017.

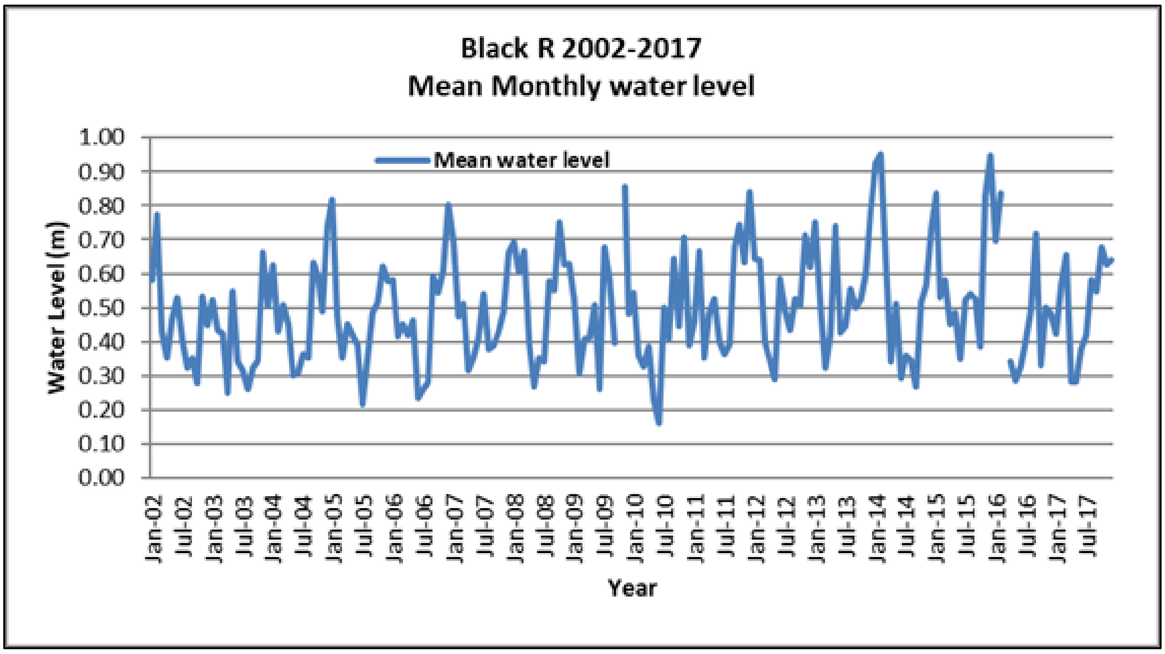

Figure 2-5: Monthly mean water levels for the Black River, 2002-2017.

2.2.4 Lough Feeagh

Lough Feeagh is situated in the Burrishoole catchment in the west of Ireland close to the Atlantic coast and is therefore strongly affected by the temperate oceanic climate that predominates in the region. The water is soft and highly coloured (2017 mean of 89 mgl^{-1} PtCo), and is oligotrophic, with Chlorophyll *a* ranging between 1 and 2µg l^{-1}. Mean annual Total Phosphorous is 6.1 µg l^{-1} (2017) and Total Nitrogen is 0.43mgl^{-1} (2017). The Lough Feeagh Automatic Water Quality Monitoring System (AWQMS) measures various parameters using a Hydrolab Datasonde 5, two Chelsea Scientific Minitrackas and a Seapoint fluorometer (pH, dissolved oxygen, temperature and conductivity, turbidity, Chl and CDOM fluorescence). There is also a thermistor chain and various weather instruments continually monitoring variables such as barometric pressure, wind speed and wind direction. In 2017, we equipped the AWQMS with an aquatic pCO2 sensor (from AMT Analysenmesstechnik GmbH: http://www.amt-gmbh.com), measuring the partial pressure of carbon dioxide in the epilimnion, with the aim of getting some data about the potential greenhouse gas (GHG) flux from Feeagh to the atmosphere. This sensor worked well in 2017 (Fig. 2.6), and the data are currently being analysed as part of Brian Doyle's PhD.

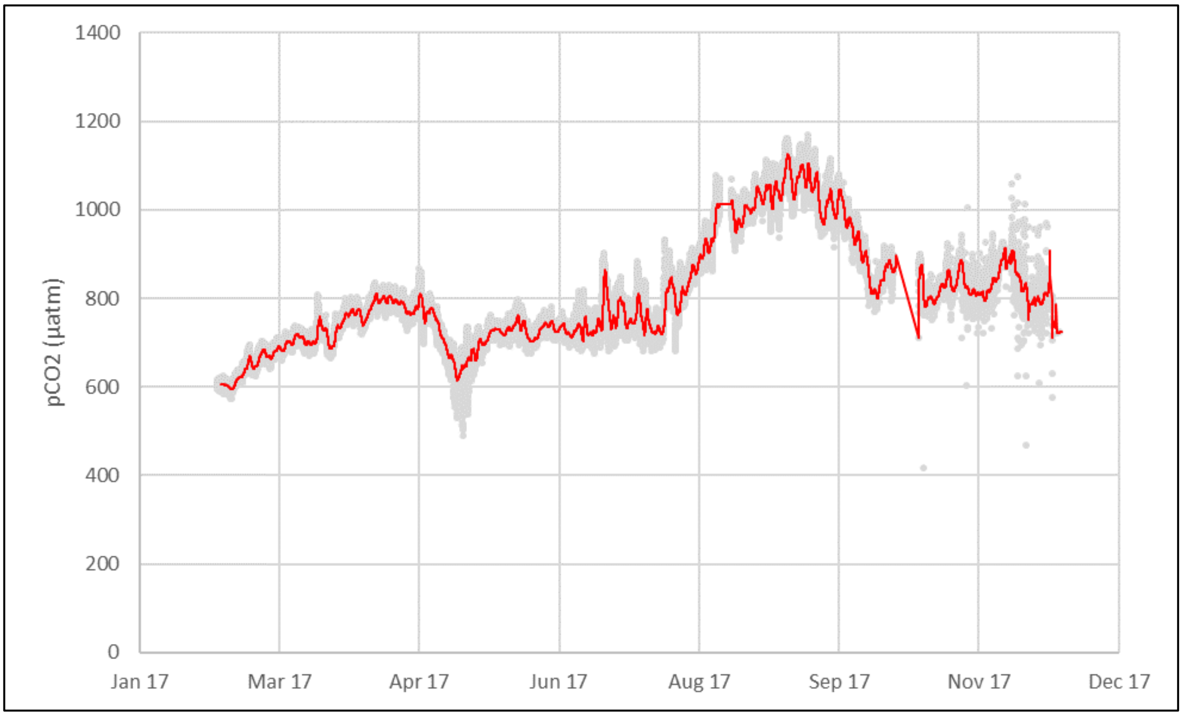

Figure 2-6: pCO2 in the epilimnion of Lough Feeagh. Grey dots are measurements taken every 10 mins, and the red line indicates a daily moving average.

The Lough Feeagh AWQMS operated well in 2017. The temperature profile indicates a period of stratification between May and October (Fig. 2.7). Summer temperatures were cooler than in 2016, with a maximum surface water temperature of 22° C . (Fig. 2.8). While stratification occurred at the start of May as normal, density differences in the water column were much lower than average, and the strength of the stratification was lower than normal for the whole year. This reflects the cooler than normal summer temperatures (Fig. 2.9).

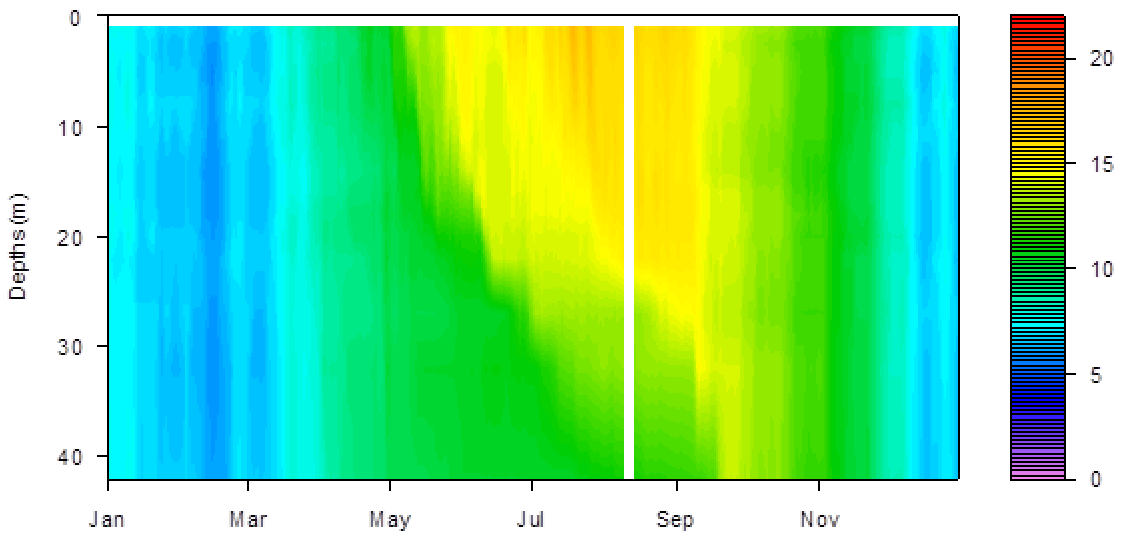

Figure 2-7: Temperature profile for L. Feeagh measured using PRT sensors on the AWQMS for 2017. The white denotes missing data.

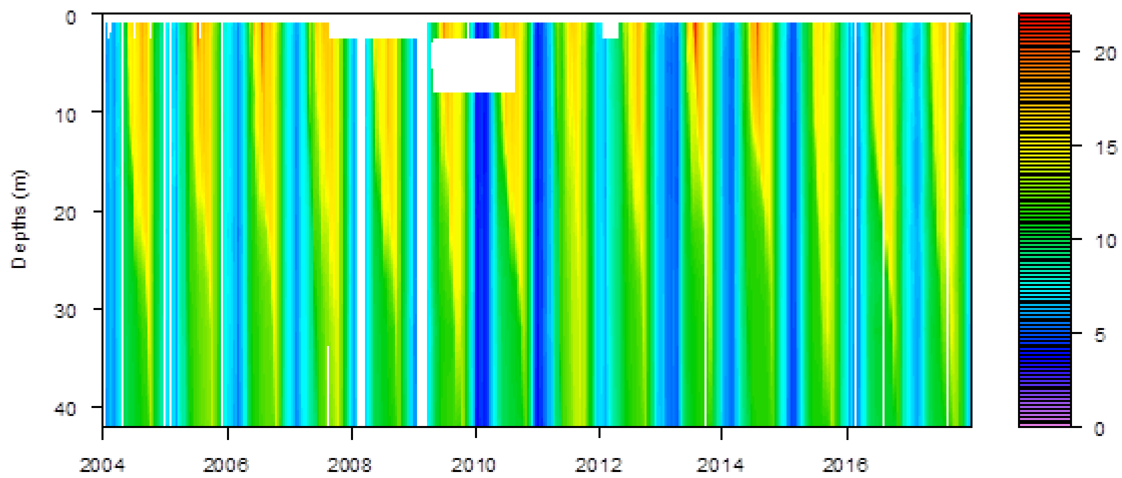

Figure 2-8: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2004-2017. The white areas denote missing data.

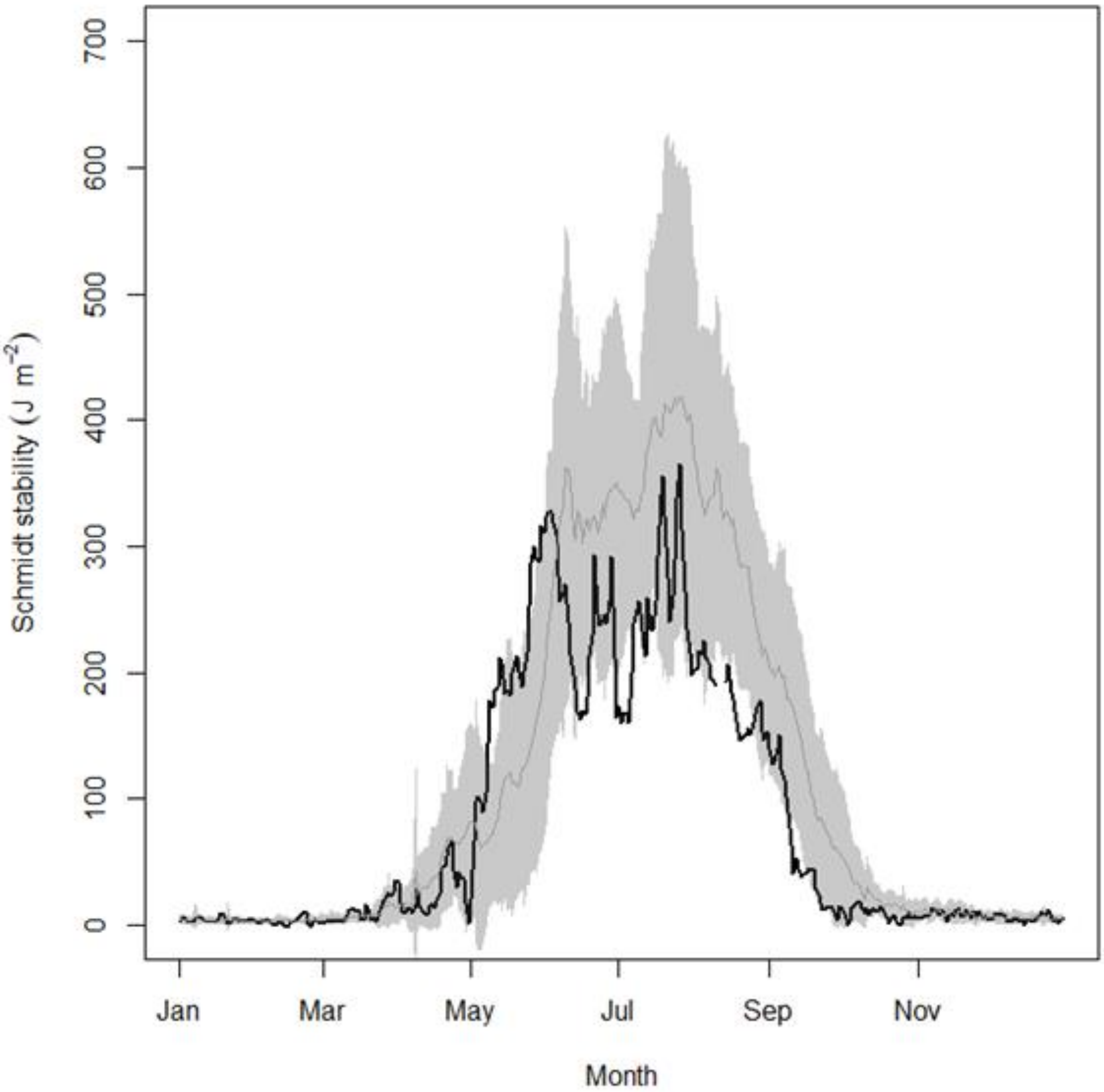

Figure 2-9: Schmidt stability of the water column on Lough Feeagh. The black line indicates the daily measured values for 2017. The grey line indicates the average daily values for the period 2004-2016 ± the standard deviation (shaded grey area).

2.2.5 Lough Furnace

Lough Furnace is situated in the lower end of the Burrishoole catchment. Lough Furnace, (2km from north to south at its widest point, covering an area of 170ha, max depth is 21m with an average depth of 7m) is a cryptodepression tidal lagoon lake. Sea water enters the lake during spring tides but the freshwater exchange ensures relativity low salinities at the surface throughout the year. The lough is thermally stratified throughout the year with spring and autumn inversions and accompanying halo- and oxyclines. Monitoring of L. Furnace commenced in the early 1970s and automatic daily monitoring commenced in May 2008. This AWQMS (Fig. 2.10) has a Datasonde DX5 attached to a profiling winch, enabling temperature, conductivity, dissolved oxygen (% and mg/l), salinity, chlorophyll fluoresence and pH profiles of the lake to be taken. The winch profiles the lake 4 times a day (6am, noon, 6pm and midnight), taking four hours to run a profile and is parked for two hours. There is also a nephelometer and fluorometer positioned one meter below the water column. All parameters are measured every two minutes. A weather station is also fully functional on the AWQMS measuring wind direction, wind speed, radiation, relative humidity and barometric pressure.

The AWQMS worked relatively well in 2017, apart from a month in the middle of the summer when there were problems with the winch operation. The water temperature displayed a typical surface cooling over winter, and epilimnetic warming during summer, with two short periods where the water column is almost isothermal (start of June and start of November) (Fig. 2.11). The hypolimnion was permanently hypoxic below 6 metres throughout the year (Fig. 2.12), apart from a short period in May, when the hypolimnion was refreshed by oxygenated tidal waters entering from Clew Bay. This phenomenon was also recorded in 2010, 2013 and 2014, but is not a guaranteed annual occurrence (Kelly *et al*, 2017). The epilimnion was very shallow between July and October, with oxygenated water only extending to ~3 metres. This was the result of low levels of freshwater flowing down from the catchment, and resulting ingress of tidal, saline waters into the main basin (Fig. 2.13). The chlorophyll sensor indicated highest levels of phytoplankton in July and August, and as with previous years, highest biomass occurred below the surface (Fig. 2.14).

Figure 2-10: The Automatic Water Quality Monitoring Station (AWQMS) on L. Furnace (left) and the meteorological instruments attached (right).

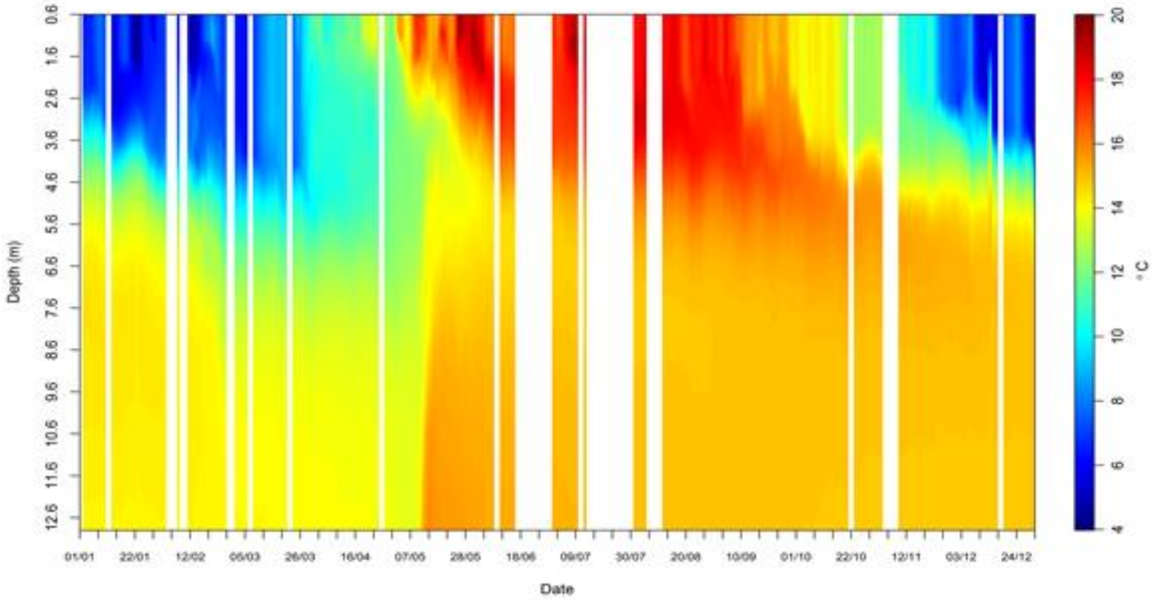

Figure 2-11: Daily average water temperatures (°C) measured every metre at the deepest point in Lough Furnace in 2017. White indicates missing data.

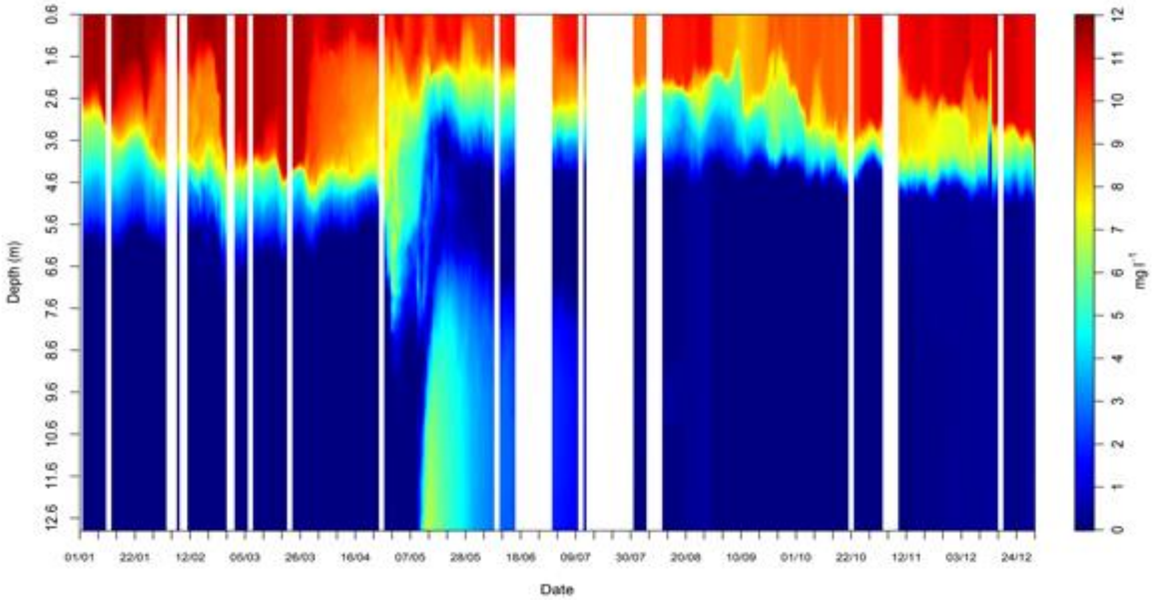

Figure 2-12: Daily average dissolved oxygen (mg/l) measured every metre at the deepest point in Lough Furnace in 2017. White indicates missing data.

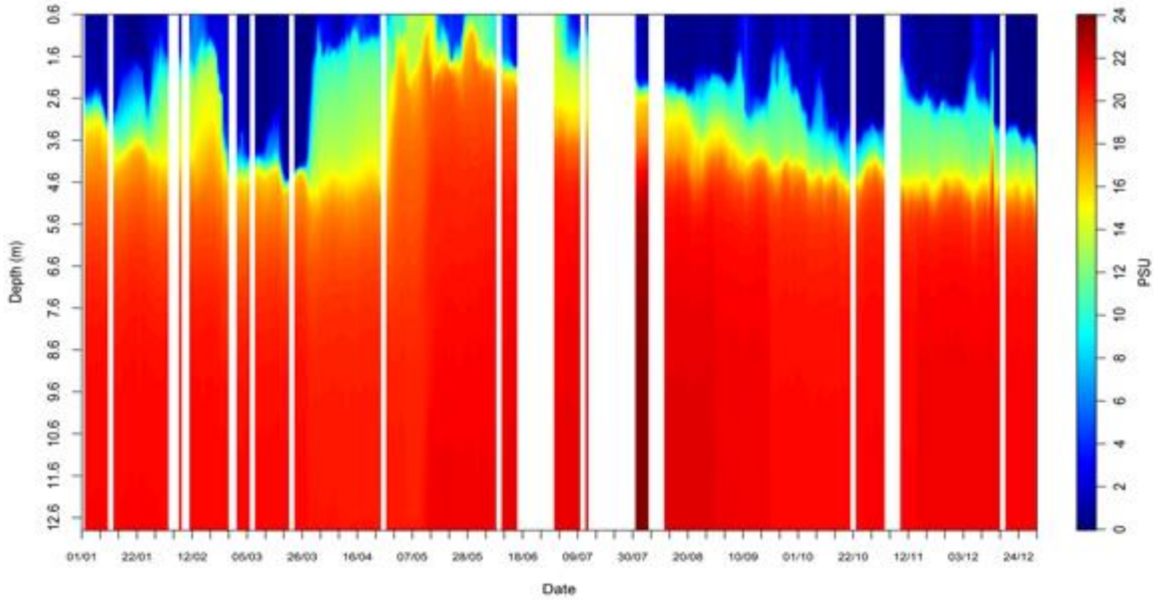

Figure 2-13: Daily average salinity (ppt) measured every metre at the deepest point in Lough Furnace in 2017. White indicates missing data.

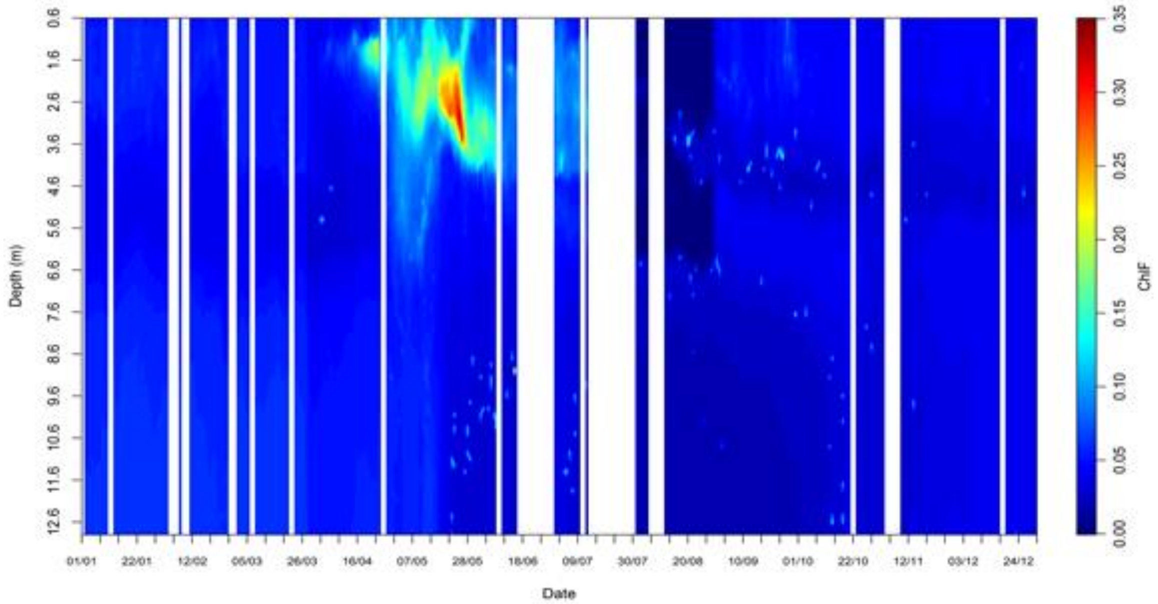

Figure 2-14: Daily average chlorophyll fluorescence (RFU) measured every metre at the deepest point in Lough Furnace in 2017. White indicates missing data.

3 Salmonid Rearing

3.1 Salmon Stocks 2016

3.1.1 Ranching

The total release of micro-tagged smolts of ranched Burrishoole grilse origin was 33,304 comprising 6 tag codes. On 27th April 2017, three tag groups (14,925) were released into Lough Furnace and one group (3,673) was released into the estuary at Burrishoole Abbey. Further releases into Lough Furnace took place on 4th May 2017 (7,486) and 12th May (7,220) to coincide with releases of acoustically tagged wild and ranch smolts. Mean weights of smolt groups released into L. Furnace ranged from 62 to 75 gm. Conditions at release were unusual following several weeks of dry conditions. Water levels in Lough Feeagh were low, restricting the movement of wild salmon smolts, and surface salinity in Lough Furnace ranged 11-14 ppt.

Tag code details are shown in Table 5.1.

3.1.2 Acoustic Smolt Tracking

As part of a Ph.D. study (MI & GMIT collaboration) investigating early migration mortality in salmon from the Burrishoole National Index River, 40 ranch and 40 wild salmon smolts were acoustically tagged during May 2017. Smolts were tracked through Furnace and into Clew Bay as far as Clare Island, using an array of receivers.

3.2 Salmon Stocks 2017

An estimated 65,000 Burrishoole ranch eyed ova from four stripping dates were retained for ongrowing. Water temperatures ranged from 8.1^{0}C at the commencement of first feeding in late March to 10.3^{0}C on 20th April when the last group commenced first feeding. Growth and survival were good with an overall survival of 85% from first feeding to grading in August. Ranch salmon were mixed in September 2017 to produce core medium and large grade release groups. Stock remaining in December 2017 was 35,718.

3.3 Salmon Stocks 2018 (Grilse ova laid down in 2017/'18)

An estimated 73% of all returns (71.8% of ranch grilse returns and 90% of 2SW returns) were processed between May and August. Predator damage was estimated to be 3.8%.

Broodstock collection commenced on 9th August 2017 and salmon were held in ponds until transfer to the broodstock holding pond on 27th September (62 males, 65 females). Broodstock collection continued into December and in total 229 ranch adults (108 females, 121 males) were held during the stripping period. Unlike in the previous two seasons when large numbers of grilse remained in the pools below the Mill Race upstream trap during summer and autumn, only 34 grilse were netted and transferred to the broodstock pond in November 2017.

Average water temperatures decreased from 7.9^{0}C to 6.0^{0}C during December. Salmon were examined over a seven week period (7th December to January 24th 2018), to recover ripe females for egg production. Surplus fish 21 (2 females, 19 males) were culled on 8th February 2018.

An estimated 312,000 green ova were produced by 96 females. The average fecundity value was 3,249 ova per grilse female (n=96). A proportion of each family, from confirmed Burrishoole stock, was retained in the hatchery from each of the six stripping dates, totalling 62,177 eyed ova from 95 females and 97 males. Ova quality and survival was good. Broodstock condition was good throughout the holding period. Thirty ranch salmon broodstock were sampled in January 2018 and subsequently certified by the Marine Institute Fish Health Unit as disease free.

A small number of adult salmon (n=16) were examined for the presence of Anasakis during the summer and Anasakis was observed in 75% of fish sampled. Where present, levels were recorded as low (< 10 per fish) or moderate (15-35 per fish) in 92% of sampled fish. In January and February 2018, salmon broodstock (n=52)) were examined to assess the incidence of the post larvae of the cestode *Hepatoxylon trichiuri*. The cestode was found to be present (usually 1 or 2 per fish) in 34.6% of fish sampled.

3.4 Experimental Trout stocks 2017

The Marine Institute are collaborating with University College Cork (UCC) on an ERC funded trout project 'Alternative life histories: linking genes to phenotypes to demography'. The overall purpose of the project is to understand how and why individuals develop strikingly different phenotypes and life histories in variable environments and how ecological change affects the composition and dynamics of wild populations. Specifically, the project will investigate the causes and consequences of 'facultative anadromy' in brown trout, the phenomenon whereby some individuals in a population migrate to the sea for part of their lives, while others remain resident in fresh water and never go to sea.

Following the production of experimental groups in 2016/17 (as detailed in Annual Report 2016) and the transfer of 13,000 unfed fry into the Shrahevagh river in March 2017, an estimated 1000 fry were retained in the hatchery for on growing. Losses were very high during the first feeding period in the hatchery and only 15% of the stock survived to June 2017. Remaining fish were sampled periodically during the year and their tissues preserved for genetic analyses.

3.5 Experimental Salmon Stocks 2017

The Institute are collaborators with UCC in a research programme funded by Science Foundation Ireland (SFI), 'Wild farmed interactions in a changing world: formulation of a predictive methodology to inform environmental best practice to secure long-term sustainability of global wild and farm fish populations'. The overall purpose of the work packages is to support studies designed to understand the genetic mechanisms (genetic architecture) underpinning the expression of critical life history traits in the wild associated with the fitness of the progeny of wild and farm salmon and the progeny of resident and anadromous brown trout.

Experimental populations were produced in 2016/17 for a work package examining the relative performance of the juvenile progeny of Atlantic salmon from farm and wild genetic backgrounds, undertaken in the experimental controlled section of the Shrahevagh river and also under hatchery conditions. Following the production of experimental groups (as detailed in Annual Report 2016) and the transfer of 29,500 unfed fry into the Shrahevagh river in April 2017, an estimated 18,000 fry were retained in the hatchery for ongrowing to the smolt stage and to measure trait responses. Fish were sampled periodically to collect tissues for gene transcriptomic, microbiome and micro-parasitic analyses.

In August 2017, fish were screened by the MI Fish Health Unit following an observed increase in mortality in the Fanad stock. Proliferative kidney disease (PKD) was subsequently detected in the Fanad stock, but was not detected in the Burrishoole wild and ranch stocks. PKD is a disease of salmonid fish caused by the endoparasitic myxozoan, *Tetracapsuloides bryosalmonae*, which uses freshwater bryozoans as primary hosts. Clinical PKD is characterised by a temperature-dependent proliferative and inflammatory response to parasite stages in the kidney. As the autumn progressed and water temperatures decreased, mortality levels in the Fanad stock declined.

In October 2017, 300 fish from each of the three progeny groups (Fanad, Burrishoole wild and Burrishoole ranch) were tagged using passive integrated transponders (PIT) and transferred to three 2.5m tanks (3 x 100/progeny group) for ongrowing to the smolt stage. Using PIT tags, which have a unique identification code, enabled UCC researchers to identify individual fish when measuring growth and trait responses. Remaining fish from each of the three progeny groups were also ongrown with a view to transferring groups to the MI marine site as smolts in 2018.

Surplus Fanad and Burrishoole ranch salmon parr were used to produce S1/2 smolts during the autumn and were transferred to the MI sea site at Lehenagh Pool in December 2017. Fanads smolts (n=5083) averaged 73g and Burrishoole smolts (n=4751) 71g at transfer.

3.6 Experimental Salmon Stocks 2018

A second experimental population was established in the 2017/18 brood season for the SFI research programme. Wild Burrishoole and farmed salmon of Fanad origin were used to produce pure bred and hybrid families. All broodstock used for egg production were certified disease free by the Marine Institute Fish Health Unit.

An estimated 41,000 unfed fry were released into the Shrahevagh river, above the trap, in May 2018. An estimated 19,600 fry, a subset of representatives from the same families and surplus Fanad stock, were retained in the hatchery for ongrowing to the smolt stage and to facilitate measurement of trait responses in hatchery stock.

4 Salmon Census Programme

The salmon census and stock assessment programme was continued in 2017 with a full upstream and downstream census of migrating wild salmon. The data provides a valuable index of salmon survivals and stock dynamics for the freshwater components of the stock.

4.1 Wild Salmon and Grilse

4.1.1 Wild Salmon & Grilse

A total of **529** wild grilse, and **3** previously spawned grilse (from floy tag returns), were recorded moving upstream through the permanent traps during the season (Table 4.1 and 4.2).

Water levels were very low during early May. Water levels increased significantly following heavy rainfall commencing on 14th May and remained sufficiently high for upstream migration for the remainder of the summer.

As in 2016 salmon were again observed accumulating in the Mill Race pool. However, due to the high water levels during October and November the pool was only draft netted once. A total of 18 salmon were captured, of which 17 were ranched and one was wild.

The total number of spring fish recorded in the upstream traps was **9**.

The total wild grilse return to fresh water was **528** and **3** previously spawned grilse

4.1.2 Farm Escapees

A total of 4 farmed salmon were identified in the upstream trap during 2017. The first recording was on August 28th and a further 3 fish were recorded in September. All of the fish were recorded in the upstream trap at the Salmon Leap and were culled. See below for details:

Date	Trap	Length cm	Weight g	Sex
28-Aug-17	SLUT	52.7	1500	M
01-Sep-17	SLUT	49.6	1400	M
04-Sep-18	SLUT	52.9	1400	M
04-Sep-18	SLUT	52.2	1400	M

4.1.3 Pink Salmon

During 2017 there was a considerable return of Pink Salmon (*Oncorhynchus gorbuscha*) to rivers across Europe, including Norway, Sweden, England, Scotland, N. Ireland, Ireland, Iceland, Denmark, Finland, France and Germany. At least 32 fish have been reported to Inland Fisheries Ireland, including one from the Owengarve River just west of the Burrishoole. None were recorded in the Burrishoole in 2017.

Table 4-1: Monthly wild grilse totals for the Salmon Leap and Mill Race traps, 2017.

Month	Mill Race	Salmon Leap	Total	%
May	1	2	3	0.6
June	13	203	216	40.8
July	25	206	231	43.7
August	3	65	68	12.9
September	0	3	3	0.6
October	0	4	4	0.8
November	3	1	4	0.8
December	0	0	0	0.0
	45	484	529	100

Table 4-2: Monthly proportions (%) of the wild grilse run timing 2006-2017.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
May	0.5	0.3	0.0	0.0	0.0	0.2	0.1	0.7	0.4	0.0	0.9	0.6
June	1.4	7.7	9.1	4.6	0.9	16.8	29.8	13.2	11.8	1.9	37.7	40.8
July	40.1	56.3	17.9	78.7	75.8	43.4	57.1	45.0	61.6	86.6	29.1	43.7
August	31.9	17.5	62.6	15.5	15.5	29.8	10.1	26.6	19.2	6.1	9.2	12.7
September	22.8	14.9	7.3	0.9	6.7	8.4	2.4	10.3	0.7	2.5	6.6	0.6
October	2.5	1.0	2.9	0.2	1.0	0.6	0.4	2.6	4.8	0.8	12.5	0.9
November	0.5	1.3	0.2	0.2	0.1	0.8	0.0	1.6	1.1	2.0	3.8	0.8
December	0.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0

Table 4-3: Wild salmon, grilse and previously spawned grilse (PSGs identified from floy tag recoveries) totals in the upstream traps, 1970-2017; 5 year means and annual data from 2000.

Year	Total Salmon	Total Grilse	Previously Spawned Grilse
1970-'74	14	1145	
1975-'79	36	703	
1980-'84	35	449	
1985-'89	22	492	
1990-'94	16	421	
1995-'99	12	509	
2000-'04	12	542	
2005-'09	22	642	
2010-'14	27	572	10.6
2000	6	568	
2001	6	368	
2002	2	648	
2003	18	544	
2004	28	580	
2005	9	532	
2006*	31	530	
2007*	12	1049	
2008	23	548	21
2009	37	549	10
2010	17	686	17
2011	50	523	7
2012	18	671	6
2013	23	710	15
2014	26	271	8
2015	11	635	4
2016	16	530	2
2017	9	529	3

* years where the grilse count was raised to account for loss in the traps.

4.2 Net marked fish in upstream traps

In 2007, the Irish Government introduced a cessation on drift netting in Irish coastal waters. The overall incidence of net marks recorded since the cessation in 2007 remains low.

There was a slight increase in the incidence of net marks on wild fish which increased from 1.4% in 2016 to 1.9% in 2017. The incidence of net marks on ranched fish increased from 0.7% to 4% for the same period. With the exception of September (only 3 fish), the highest monthly occurrence of net marks was in July for both wild fish (2.2%) and for ranched fish (5.1%) (Table 4.4)

Table 4-4: Percentage occurrence of net marks on wild and reared salmon, 2017.

	Wild Grilse %	n for wild/month	Reared Grilse %	n for reared/month
May	0	3	0	1
June	1.4	215	3.5	173
July	2.2	229	5.1	544
August	1.5	66	2.9	280
September	33.3	3	2.6	39
October	0	5	0	9
November	0	5	0	37
December	0	0	0	0
Total	1.90%	526	3.97%	1083

4.3 Wild Spawning Stock

The spawning stock (escapement) represents the number of fish available for spawning. It is calculated by subtracting rod caught fish and downstream-displaced fish as well as losses due to poaching, disease and predation, which have been estimated at 5% for wild fish and 10% for reared fish not displaced downstream.

In both 2006 & 2007, an additional number of fish, reared and wild, escaped upstream undetected (see previous reports). It is likely that the wild grilse count for those years were minimum figures and this was taken into account for all calculations based on the 2006 & 2007 spawning escapements.

4.3.1 Spawning escapement and stock

The total spawning stock in 2017 consisted of 478 wild fish and 52 reared fish (Table 4.5). The reared component was derived from 108 reared fish tagged and released upstream. Wild broodstock were collected from the traps and catchment for a SFI contracted project (see Sec. 4.3.2).

Table 4.6 gives the annual total spawning escapement, the wild escapement and the reared fish component. The spawning escapement of wild fish in 2007 was the highest observed over the last two decades. Particularly poor wild escapement was recorded in the 1990s, in 2001 and in 2014.

Table 4-5: Spawning stock of salmon and grilse, 2017.

	Wild grilse (1SW) & previously spawned grilse	Wild Salmon (2SW)	Ranched fish released upstream
Counted in trap	532	9	108
Rod Feeagh	0	0	0
Culled	5	0	0
Broodstock UT	7	0	0
Broodstock DT	3	0	53
Broodstock Upper Catchment	20	0	0
Estimated morts.	26	1	3
Displacement	1	0	0
Spawning stock	**470**	**8**	**52**

Table 4-6: Spawning escapement, 1970-2017.

	Maximum spawning escapement	Wild fish component	Reared fish component
1970-'74	1126	986	140
1975-'79	725	683	42
1980-'84	474	430	44
1985-'89	662	428	232
1990-'94	603	348	254
1995-'99	519	428	95
2000-'04	516	494	21
2005-'09	624	587	38
2010-'14	571	544	27
2005	503	472	31
2006	552	520	32
2007	1038	958	80
2008	512	495	17
2009	517	489	28
2010	652	617	38
2011	548	512	36
2012	668	640	28
2013	702	691	11
2014	284	260	24
2015	601	583	18*
2016	539	492	47
2017	530	478	52

* estimated, see table 4.5.

4.3.2 Wild salmon broodstock stripped December 2017

In 2017 the following were collected for wild broodstock for the SFI research project; seven wild fish were collected from the upstream traps, three from the downstream trap and 20 from the Shrarevagh River in the catchment.

4.4 Survival from Ova to Grilse

The relevant brood year for the 2017 grilse was 2013 with ova hatched in 2014 and smolt migration in 2016 (Table 4.7).

As in previous years, it has been assumed for the purpose of estimating survival that ranched grilse spawned naturally. Specific data are not currently available on differential survival rates of wild and ranched stocks spawned in the wild. All relevant calculations are based on parameters set out in the Ann. Rep. No. 19, 1974.

Table 4-7: Survivals from ova to smolt and smolt to grilse.

Spawning escapement in 2013	702
No. of females	351 -386
Ova deposition	1404000 - 1588801
No. of smolts in traps 2016	7362
No. of smolts released	7170
Survival ova to smolt	0.52 - 0.46
No. returning grilse 2017	529
Survival smolt to grilse	7.4
Survival to grilse per grilse female	1.5 - 1.4

* two estimates of the % females in the run using 50% and 55%

4.5 Ova to Smolt and Smolt to Grilse Survival

The survival of ova to smolt recorded in 2017 was 0.5 from a spawning escapement of 702 adults (Table 4.7).

The percentage return of grilse in 2017 from the 2016 smolt output was 7.4% and was slightly lower than the previous year at 7.8%.

The survival to grilse per grilse female was 1.4 – 1.5 (Tables 4.7- 4.8).

Table 4-8: Percent survivals for ova to smolt and grilse per female grilse spawner; comparative data for 5-year averages from 1970-1989 and values for the individual brood years from 1990 onwards.

Brood year-class	% survival rates ova to smolt	survival rates to grilse per grilse female spawner
1970-'74	0.48 - 0.62	1.4 - 1.7
1975-'79	0.63 - 0.73	1.5 - 1.7
1980-'84	0.61 - 0.69	1.7 - 1.9
1985-'89	0.44 - 0.45	1.4 - 1.5
1990	0.47 - 0.54	1.8 - 2.0
1991	0.47 - 0.53	1.8 - 2.0
1992	0.48 - 0.54	1.3 - 1.5
1993	0.39 - 0.45	1.5 - 1.6
1994	0.36 - 0.41	1.3 - 1.4
1995	0.83 - 0.93	1.9 - 2.1
1996	0.53 - 0.61	1.8 - 1.9
1997	0.52 - 0.59	1.4 - 1.5
1998	0.58 - 0.60	2.4 - 2.6
1999	0.79 - 0.70	1.8 - 2.0
2000	0.56 - 0.64	1.9 - 2.1
2001	1.30 - 1.10	2.9 - 2.6
2002	0.56 - 0.64	1.7 - 1.9
2003	0.68 - 0.76	3.7 - 4.1
2004	0.53 - 0.60	1.8 - 2.0
2005	0.69 - 0.61	2.0 - 2.2
2006	0.75 - 0.67	2.4 - 2.6
2007	0.34 - 0.30	0.9 - 1.0
2008	0.65 - 0.57	2.4 - 2.6
2009	0.75 - 0.66	2.7 - 2.5
2010	0.49 - 0.43	0.8 - 0.9
2011	0.66 - 0.74	2.3 - 2.1
2012	0.47 - 0.53	1.6 - 1.4
2013	0.46 - 0.52	1.5 - 1.4

4.6 Salmon Smolts

4.6.1 Wild Salmon Smolts

Water levels remained low throughout April and into early May. Water levels at the Salmon Leap dropped in early May to a level that there was insufficient water for fish to enter the trap. During this period there was an increase in wild salmon smolt numbers at the MRDT. Very low water conditions at the Salmon Leap lasted to Sunday 14th May when heavy rainfall during the night raised water levels significantly. Water levels continued to rise during May 15th and as a result over 900 were recorded in the SLDT.

The number of smolts counted decreased from 7362 in 2016 to 5029 in 2017. Due to the low water conditions there was an increase in the number of smolts recorded in the Mill Race traps at 2349 and 2680 in the Salmon Leap. (Table 4.10).

In addition to the routine counting and sampling of wild smolts additional sampling was also carried out to support two Cullen fellowship projects examining salmonid migration.

4.6.2 PIT Tag Recaptures

99 wild salmon smolts with PIT tags were recorded in the downstream traps between January and June and a further 6 fish were recorded in October/November as wild salmon parr with PITs. These fish were previously tagged as parr in the catchment as part of a Cullen Fellowship project.

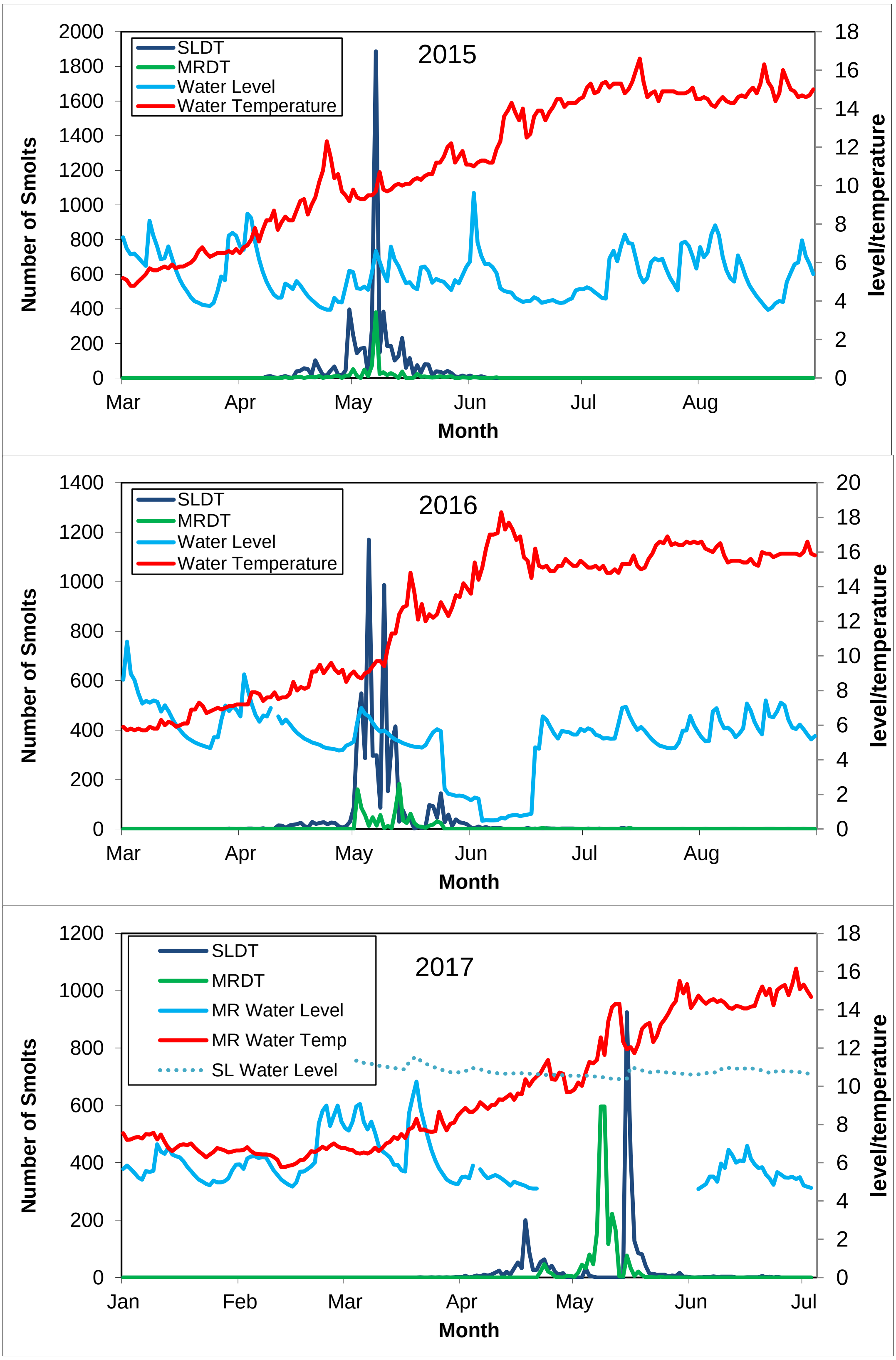

Figure 4-1: Timing of the 2015, 2016 and 2017 wild salmon smolt runs in the Salmon Leap and Mill Race traps with daily midnight MR water level (m x 10) and midnight temperature (⁰C). The Salmon Leap water level has been inserted to cover the gap in the MR data.

Table 4-9 : Number of wild salmon smolts counted in 2017.

Month	Salmon Leap Down Trap	Mill Race Down Trap	Total
March	7	0	7
April	811	116	927
May	1819	2233	4052
June	40	0	40
July	2	0	2
August	1	0	1
September	**0**	**0**	**0**
TOTAL	**2680**	**2349**	**5029**

Table 4-10: Annual numbers of wild salmon smolts recorded in the downstream traps and the number released after sampling and mortalities have been removed..

Year	1990-'94	1995-'99	2000-'04	2005-'09	2010-'14	2011	2012	2013	2014	2015	2016	2017
Smolts Count	5618	7052	7490	7351	7195	6629	7717	6357	8150	7034	7362	5029
Smolts Release		6967	7340	7138	6966	6390	7542	5960	7957	6832	7170	4918

4.6.3 Ranched Salmon Smolts

There were no ranch smolts released into the catchment above the traps in 2017.

4.7 Wild Salmon Kelts

4.7.1 Census

Kelts migrate downstream after spawning. In December 2015, Storm Desmond caused considerable damage to the Mill Race channel and the right hand third of the fish fence on the Salmon Leap Downstream Trap. It was not possible to make a repair to this until 23rd March 2016. The kelt data for 2015/'16 were therefore incomplete.

A total of 208 wild salmon kelts were recorded in the downstream traps between December 2016 and May 2017 (Table 4.11).

Survival of wild fish to kelt was 42.1% and over 96% of these were recorded as being in good condition (Table 4.12).

Table 4-11: Numbers of wild salmon kelts counted in 2017.

Month	SLDT	MRDT	Total
December '16	7	3	10
January '17	11	3	14
February	78	11	89
March	80	5	85
April	3	0	3
May	4	3	7
June	0	0	0
	183	**25**	**208**

4.7.2 Tagging of wild kelts

Following the cessation of drift netting during 2007 and the corresponding increase in the wild spawning stock at Burrishoole, annual tagging of the wild kelts recommenced during 2008.

A total of 193 floy tagged kelts were released from the downstream traps in 2017. During the summer of 2017 a total of 3 previously spawned grilse were recovered. The percentage recovery of PSGs increased from 1.4% in 2016 to 1.6% in 2017 (Table 4.12).

Table 4-12: Comparison of annual salmon kelt runs.

Year	Kelt Quality Grade				
	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980-84	82	18	6.7	48.7	9.7
1985-89	88	21	5.1	43.2	8.4
1990-94	92	31	4.8	61.4	6.6
1995	74	28	18.3	59.9	2.3
1996	88.1	27	10.1	53.1	4.0
1997	93.7	33.5	6.3	58.9	*
1998	94.3	30.8	5.7	67.6	*
1999	90.6	38.5	4.5	76	*
2000	92.5	44.5	5.5	62.1	*
2001	97	38.5	2.8	72.5	*
2002	91.3	40.9	7.8	49.6	*
2003	95.5	37	3.5	42.3	*
2004	89.9	36.3	9	53.2	*
2005	83.3	35.5	15.3	57.6	*
2006	82.2	36.1	16	54.4	*
2007	95	37.3	4.1	**	*
2008	93.2	26.9	6.8	**	5.6
2009	96.1	20.8	3.3	43.8	4.9
2010	98.1	13.5	1.3	34.2	10.1
2011	95.9	22.7	0.5	35.5	4.1
2012	96.7	20.8	2.8	54.7	3.6
2013	95.1	29.6	4.6	53.9	4.5
2014	91.3	40.7	6.7	51.4	2.4
2015	88.6	27.8	9.8	61.2	2.7
2016	93.8	18.8	6.3	26.6	1.4
2017	96.1	20	3.4	42.1	1.6

* no kelt tagging

** see section 4.7 (2007 report)

*** Data compromised by Storm Desmond (see 2016 Report)

A = % healthy kelts in kelt run

B = % males in kelt run

C = % lightly marked

D = % survival from wild spawning escapement

E = % recapture of previously spawned grilse in first year

5 Reared Salmon Census Programme

A programme of rearing and releasing tagged salmon has been carried out in Burrishoole since the early 1960s. The stock was based originally on donor wild salmon from the Burrishoole system and the stock has been closed since using returning tagged fish as broodstock. Additional experimental groups are sometimes released and these are freeze branded and differentially tagged so as to distinguish them from the core ranched stock and avoid including them in the ranched broodstock. The ranched stock facilitates data collection and comparison with the wild stock without putting undue stress or mortality on the wild stock – in this report the ranched stock are known as reared grilse and reared 2SW salmon.

5.1 Coastal Returns

Details of coastal returns of Burrishoole fish are available in the Marine Institute 'National Report for Ireland - The 2017 Salmon Season' report.

5.2 Return rate of reared and wild grilse

A total of 1154 nose-cores were recovered from reared fish returning to Burrishoole in 2017 consisting of 12 different microtag codes. Of these fish, 10 were identified as multi sea winter fish and 1129 as one sea winter (grilse) and fifteen had no tags.

The percentage return for grilse released in Lough Furnace ranged from 3.3% to 3.6% with an average of 3.6%. The return rate of smolts released into Lough Feeagh from release was 2.9% on March 30th and was 3.5% from smolts released from the downstream traps.

The percentage return of wild grilse in 2017 from the 2016 smolt output was 7.4% and was slightly lower than that of the previous year of 7.8%.

5.3 Recapture of Reared 2SW Fish

The total number of microtagged 2SW reared fish recorded returning to Burrishoole during 2017 was 10, comprising of 5 core release groups. The largest fish was 81.1 cm and 5.6Kg.

5.4 Smolt Releases 2017

A total of 33,304 ranched smolts were released from Burrishoole during 2017. They consisted of six individual microtag codes, five of which were released into Lough Furnace, one into the estuary at Burrishoole Abbey. Four of the releases were carried out on April 27th, one group was released on May 4th and the final group was released on May 12th.

For additional information, see section 3.1.1.

Table 5-1: Details of microtag codes and smolt release groups 2017.

Group ID	Tag Code	Mean Wt	Mean Length	No. Released	Date released
Core	47/7/73	74.00	18.7	7,533	27/04/2017
Core	47/7/92	75.80	18.0	7,486	04/05/2017
Core *	47/7/93	76.40	18.7	7,220	12/05/2017
Core	47/7/94	73.60	18.5	3,763	27/04/2017
Core (estuary)	47/7/95	63.10	17.7	3,673	27/04/2017
Core	47/8/03	63.00	17.5	3,629	27/04/2017

* 7220 released 12/5/2017 and remaining 245 released 16/5/2017

5.5 Reared kelts

Reared fish often move downstream throughout the late summer and autumn and these are collected for broodstock. A general cut-off date of the 1st December is used to separate these pre-spawned migrants and post-spawned kelts. However, some of the fish migrating downstream in December might not actually have spawned and might end up in the broodstock.

In 2016, a total of 117 ranched fish were released upstream during the summer. By the end of November 2016 a total of 81 were recaptured in the downstream traps of which 72 were transferred to the broodstock ponds. In 2017 an additional 17 fish were recaptured in the downstream traps. Therefore a total of 98 (84%) of the 117 fish were accounted for in the downstream traps.

In 2017, 108 were released upstream during the summer. By the end of November 2017 a total of 53 ranched fish were recaptured in the downstream traps and transferred to the broodstock pond. In 2018, an additional 20 fish were recaptured in the downstream traps. Therefore, the total recapture from the 108 released upstream was 73 fish (67.6%).

6 Wild Sea Trout Census Programme

6.1 Upstream Movements: Timing and Numbers.

A total of 10 wild silvered sea trout and a further 53 non-silvered trout migrated upstream through the traps in 2017. Of the silvered trout, 2 were adults and 8 (80%) were finnock. The numbers are compared with other years in Table 6.1. Of the total run of migratory (silvered and unsilvered) trout (63), 84% were unsilvered. For the purposes of this report, the unsilvered trout are not included with the sea trout. Table 6.1 shows that the numbers of sea trout have not recovered in the Burrishoole system and have shown a ten-fold drop since the 1970s.

The timing of the sea trout run in 2017, and in previous years, expressed in monthly percentages, is given in Table 6.2. The highest proportion of sea trout, both finnock and adults, moved upstream in June (20%) and July (60%). The unsilvered trout moved upstream from June through to December, with the highest proportion in July and September.

Table 6-1: Annual runs of sea trout recorded in the traps.

Year	Mill Race	Salmon Leap	Total	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	72	206	
1995-99	86	91	177	
2000-04	32	64	97	
2005-09	21	44	65	
2005	5	10	15	
2006	16	22	38	
2007	35	59	94	
2008	4	36	40	
2009	45	93	138	
2010	10	62	72	
2011	15	53	68	
2012	19	120	139	
2013	20	50	70	
2014	16	126	142	
2015	31	28	59	
2016	8	73	81	
2017	1	9	10	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

Table 6-2: Timing of the Burrishoole (a) silvered sea trout run and (b) unsilvered trout run (in monthly percentages). (n = no. of trout).

(a) Silvered Trout

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04 (483)	2005-'09 (325)	2010-'14 (491)	2015 (59)	2016 (81)	2017 (10)
May	-	0.2	0.5	0.1	3.1	2.0	1.3	3.2	0.0	6.2	0.0
June	13.1	24.6	9.4	8.4	8.6	16.7	9.0	6.1	6.3	21.0	20.0
July	54.4	44.9	62.2	55.0	42.4	37.5	32.5	54.0	75.0	58.0	60.0
Aug	15.8	10.3	18.4	16.5	19.3	26.4	38.1	22.3	18.8	12.3	10.0
Sept	7.6	14.8	3.7	8.5	9.8	5.7	13.6	7.8	0.0	1.2	10.0
Oct	6.4	3.5	4.1	7.9	12.2	10.2	4.7	4.9	0.0	1.2	0.0
Nov	2.4	1.5	1.5	2.9	4.3	1.5	0.7	1.6	0.0	0.0	0.0
Dec	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0

(b) Unsilvered Trout

	2005-'09 (408)	2010 (104)	2011 (87)	2012 (47)	2013 (101)	2014 (91)	2015 (79)	2016 (95)	2017 (53)
April	1.4	0.0	3.4	0	1.0	3.3	1.3	0	0.0
May	7.2	1.0	5.7	0	3.9	9.9	3.8	29.79	0.0
June	12.4	0.0	3.4	21.7	6.9	12.1	2.5	25.53	11.3
July	18.3	44.2	12.6	17.4	9.9	30.8	34.2	14.89	37.7
Aug	20.5	16.3	14.9	13.0	34.7	4.4	20.3	12.77	9.4
Sept	9.6	17.3	11.5	13.0	9.9	3.3	7.6	9.574	15.1
Oct	15.7	7.7	11.5	19.6	24.8	25.3	12.7	2.128	11.3
Nov	10.2	11.5	36.8	6.5	5.0	6.6	13.9	4.255	7.5
Dec	4.8	1.9	0.0	8.7	5.0	4.4	3.8	1.064	7.5

6.2 Spawning Escapement

With the continuation of the catch and release bye-law into the 2017 fishing season, no sea trout were reported killed by anglers on L. Feeagh in 2017. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 63, of which 53 were non-silvered sea trout.

Table 6-3: Annual spawning escapement of sea trout into freshwater, 1970-2017.

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04	2005-'09	2010-'14	2015	2016	2017
Max. Escap.	2090	1146	906	231	289	156	146	184	138	176	63
Revised	1622										

6.3 Downstream Movements, Sea Trout Smolts

The 2017 smolt run amounted to 291 smolts, all were released downstream (Table 6.4). Few smolts were recorded from January to March. The main migration occurred in April (19.9%) and May (67.7%) and was strongly regulated by both water level and water temperature (Fig. 6.1). The 2017 smolt count was low compared to previous years and may have been influenced by the drought and high temperatures in April and May (Table 6.5). Seven sea trout smolts had been previously PIT tagged in the catchment.

A total of 215 wild trout smolts were measured in 2017. Length measurements were taken to facilitate an estimated age breakdown of the smolt run. The estimated statistics for the 2017 smolts were a mean length of 19.1 cm and a range from 14.1 to 24.5 cm and the length frequency is presented in Figure 6.2 compared with that of 2015 and 2016. This gave an estimated age of 85.4% 2 year old and 14.6% 3 year olds.

Table 6-4: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

Month	Salmon Leap	Mill Race	Total	%
January	1	0	1	0.3
February	13	0	4	4.5
March	10	5	15	5.2
April	50	8	57	19.9
May	174	23	193	67.7
June	6	0	6	2.1
July	1	0	1	0.4
Total	255	36	291	
Number Released Downstream			291	

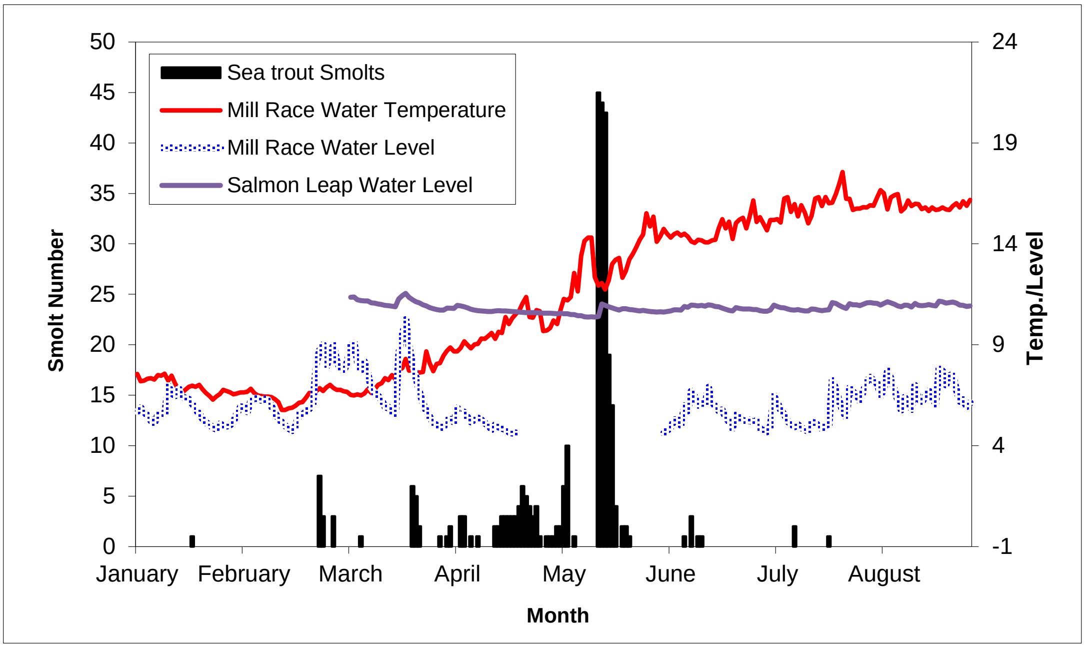

Figure 6-1: Timing of the 2017 wild sea trout smolt migration with daily midnight water level (m x 10) and midnight temperature (^{0}C - tidbit). Also included is the Salmon Leap water level (m).

Table 6-5: Annual sea trout smolt numbers in Burrishoole for 1970 to 2017.

	1970-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-'14	2015	2016	2017
Number of Smolt	4176	4038	4119	1531	1361	816	609	475	426	356	291
Number sacrificed				144	35	24	6	10	3	2	0

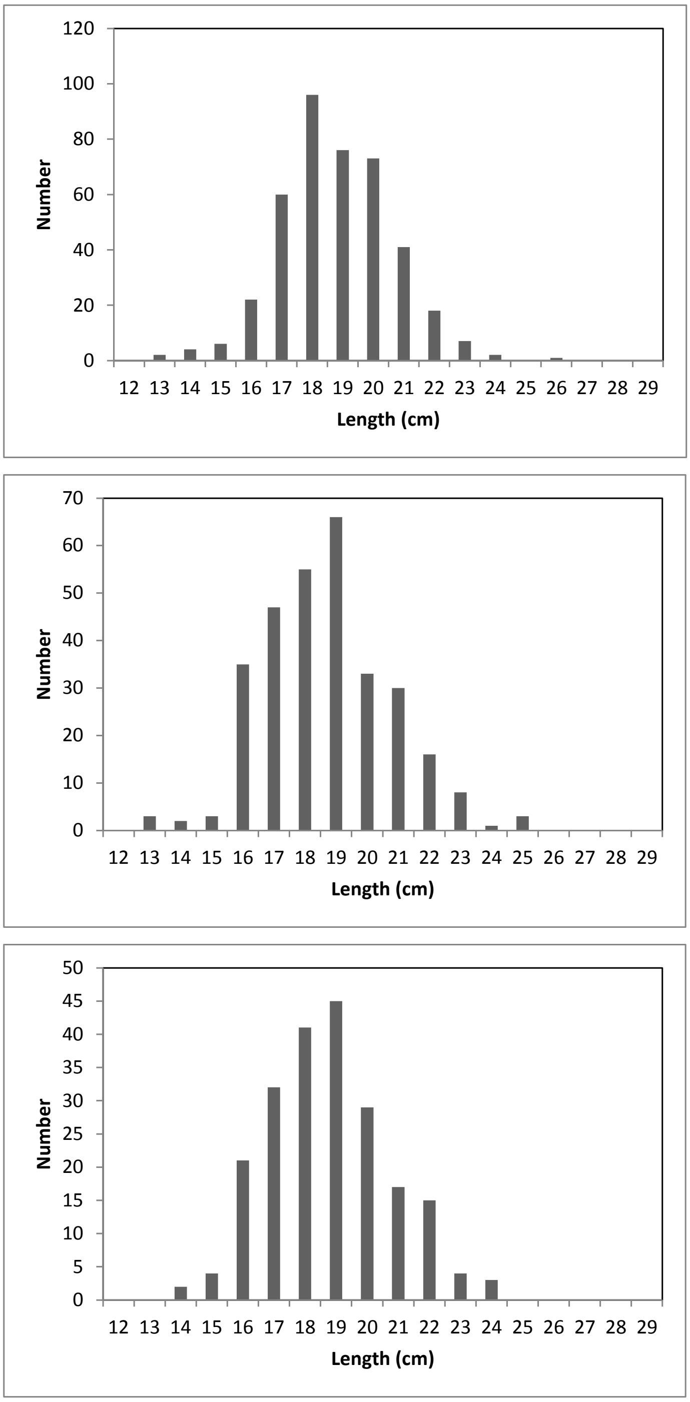

Figure 6-2: Length distributions for smolts in the Burrishoole system, top graph 2015 (n=408), middle graph 2016 (n=302) and bottom graph 2017 (n=213).

6.4 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock being displaced downstream. It is known through mark-recapture studies that a proportion of the 1+ autumn trout do return the following year as silvered finnock. These runs of trout would appear to becoming more prolonged with substantial numbers of un-silvered 0+ and 1+ trout continuing to migrate downstream in the early months of the year.

A total of 692 juvenile trout entered the downstream traps between July 2017 and May 2018 (Table 6.6). The percentage of 0+ trout that migrated over the period was 37.0% (Table 6.7).

NOTE: 1+ Autumn trout were sampled using TSUs for genetics as part of the ERC trout pedigree genetics project. As part of the Salmonid Cullen project (Ross Finlay), 186 1+ trout were PIT tagged in the downstream traps and a further 12 trout from previous tagging in the catchment were recaptured in the downstream traps between September and December.

Table 6-6: Numbers of migrating autumn juvenile trout in 2017, to the end of May 2018.

	0+		1+		Total	
Month	**Salmon Leap**	**Mill Race**	**Salmon Leap**	**Mill Race**	**Salmon Leap**	**Mill Race**
July	1	0	1	2	2	2
August	3	1	12	0	15	1
September	45	2	56	2	101	4
October	76	2	126	1	202	3
November	58	7	122	11	180	18
December	22	2	48	1	70	3
January '18	17	2	18	0	35	2
February '18	5	0	9	2	14	2
March '18	8	0	8	0	16	0
April '18	4	0	9	0	13	0
May '18	1	0	5	3	6	3
Total	240	16	414	22	654	38
Overall Total	256		436		692	

Table 6-7: Percentage of 0+ juvenile trout (<10cm) in the trapped autumn migrating trout.

Year	% 0+	Year	% 0+
1982	50.0	2000	47.8
1983	N/A	2001	56.3
1984	55.8	2002	32.8
1985	30.3	2003	48.9
1986	16.1	2004	35.5
1987	35.3	2005	37.3
1988	60.9	2006	51.2
1989	37.2	2007	27.9
1990	35.2	2008	28.2
1991	26.0	2009	25.0
1992	38.2	2010	34.9
1993	27.6	2011	37.6
1994	16.8	2012	47.3
1995	25.3	2013	36.1
1996	34.0	2014	36.6
1997	18.7	2015	27.2
1998	33.5	2016	46.4
1999	42.0	2017	37.0

6.5 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ year olds, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known. It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus the figures for total recruitment up to this time are over-estimated (Table 6.8).

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 6.9). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts. The fate of 1+ unsilvered juveniles migrating down in January to May is unknown but seems unlikely these will contribute to the 2+ spring smolt migration.

Table 6-8: Estimates of total migrant trout recruitment up to 1981.

Year	Smolt Total	Autumn trout (preceding year)	Total Recruitment
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

Table 6-9: Estimates of total migrant trout recruitment from 1982 to date.

Year	Smolt Total	1+ Autumn trout (preceding year)	Total Recruitment
1982-84	3714	1203	4917
1985-89	3706	1063	4778
1990-94	1788	399	2187
1995-99	1361	498	1860
2000-04	816	578	1377
2005-09	610	449	1059
2010	213	267	480
2011	620	501	1121
2012	632	493	1125
2013	485	536	1021
2014	427	351	778
2015	426	481	907
2016	356	334	690
2017	291	365	656

6.6 Marine Survival

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock (0+ sea age) in the same year historically ranged from 11.4% to 32.4% (Fig. 6.3). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's rising to 16.7% in 1999, 18.1% in 2009 and 17.5% in 2010 – the highest return rates since 1986. These increases were not, however, always sustained in subsequent years and there was a collapse in 2005 down to 1.5%. This was associated with the heaviest infestations of sea lice observed in the Burrishoole area since 1992. The return of smolt as finnock in 2011 was 5.8%, 13.8% in 2012, 11.0% in 2013 and 29.5% in 2014 – the highest recorded level since the mid-1970s. The return in 2017 was 2.8%

The total survival of smolts to their first return to freshwater as finnock in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills *et al*, 1990)) also showed a drop in survival from 1987 to 1989 (Fig. 6.4).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.2% for the 1993 year class of smolts. There was a further increase in 1994 to 17.0% but a drop in 1995 to 8.4%. There were marginal improvements again in 1996 (12.8%) and 1997 (13.1%), a drop to 8.3% in the 1998 year class and a marked improvement in the 1999 year class where marine survival was 20%, the highest recorded in 12 years and back within the pre-collapse historical range. Total survival increased for the 2009 cohort to the highest recorded level since 1988 of 23% and to 23.2% for the 2010 cohort. For the 2011 cohort of smolts, it was 10.2% and for the 2012 cohort it was 17.1%. In 2013 it was 14.4% and rose to 33.0% in 2014 but following the fall in finnock return in 2015 the total return in 2016 fell to half that of the previous year. The total return of 2016 smolts in 2017 was 18.0%.

NOTE: The data used in Chapter 6.6 have been updated in 2014 following a comprehensive data quality control project. None of the changes were significant and the main changes were in 2011 and 2012 following a reclassification of trout considered to be silvered and unsilvered.

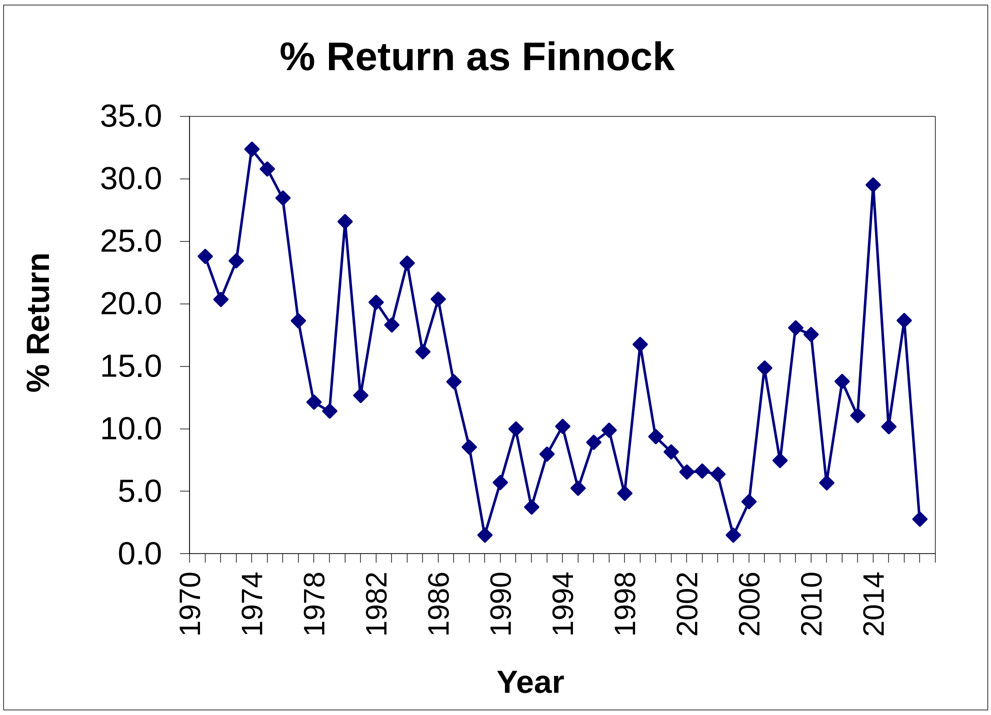

Figure 6-3: Annual percentage return of smolts returning as finnock to the Burrishoole system.

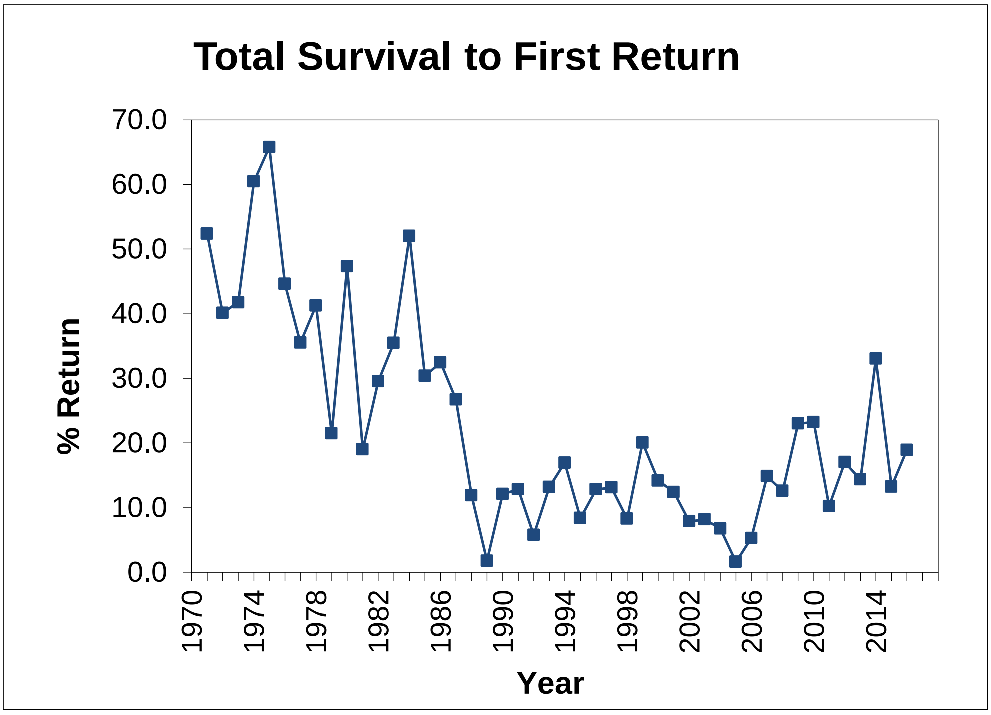

Figure 6-4: Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

6.7 Sea Trout Kelts

Table 6.10 gives the numbers of sea trout and brown trout kelts, both spawned and immature, counted downstream in the winter of 2016 and spring of 2017.

The freshwater survival of kelts is given in Table 6.11. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 6.11. In addition to the size overlap, trout counted upstream as unsilvered migrants may be counted downstream as silvered kelts, and immature autumn downstream migrants may be misidentified as brown trout kelts, both causing additional difficulties in making survival estimates.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may over-winter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

In 2016/17, overall sea trout kelt survival was 48.2% and for finnock only (small sea trout) it was 39.4%. These survivals were relatively low compared to previous years. However, there was a relatively high unsilvered (BT) count downstream so some of these may account for additional sea trout. The total downstream count of sea trout and BT was 235, from an upstream count in 2016 of 176 fish.

Table 6-10: Timing and numbers of sea trout kelts for the 2016/2017 season.

Month	Large ST	Small ST	BT	Total ST	Total Trout
October '16	0	0	2	0	2
November	0	1	13	1	14
December	1	4	34	5	39
January '17	0	4	8	4	12
February	2	10	65	12	77
March	6	1	63	7	70
April	3	2	5	5	10
May	1	3	2	4	6
June	0	1	4	1	5
Total	13	26	196	39	235

Table 6-11: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)	Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66	1997	97.00%	" *
1977	63	45	1998	140.10%	" *
1978	50	66	1999	110.40%	" *
1979	33	107*	2000	70.10%	"
1980	50	82	2001	82.00%	" *
1981	44	345*	2002	129.60%	" *
1982	53	203*	2003	66.10%	"
1983	63	177*	2004	120.50%	"*
1984	74	210*	2005	142.20%	"*
1985	70	98	2006	110.50%	"
1986	66	72	2007	228.90%	"**
1987	58.70%	(combined)	2008	98.90%	"**
1988	65.50%	"	2009	107.50%	"*
1989	68.70%	"	2010	59.40%	"
1990	79.00%	" *	2011	88.90%	"*
1991	98.70%	" *	2012	117.65%	"*
1992	89.50%	" *	2013	161.33%	"*
1993	96.70%	" *	2014	87.14%	"
1994	104.60%	" *	2015	92.81%	"
1995	96.20%	" *	2016	115.30%	"*
1996	127.70%	" *	2017	48.20%	"

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

7 Silver Eel Census Programme

7.1 Numbers

The total run amounted to 2210 eels, lower than recorded in 2016. As in other years, the highest proportion of the total catch (83%) was made in the Salmon Leap trap.

The silver eel season in 2017 was characterised by the lack of any major floods or storm events. The eels migrated on small floods and flow rates were easy to manage.

In 2017, the timing of the run was 15% migrating in August, 31% in September and 40% in October (Table 7.1). 90% of the run was completed by the end of October. Figure 7.1 shows the daily counts of silver eels.

Table 7-1: Timing and numbers of the 2017/'18 silver eel run.

	Salmon Leap	Mill Race	Total	%
May	2	0	2	0.1
June	0	0	0	0.0
July	90	1	91	4.1
August	252	75	327	14.8
September	603	81	684	31.0
October	713	171	884	40.0
November	153	40	193	8.7
December	21	2	23	1.0
Jan. 2018	2	0	2	0.1
February	1	0	1	0.0
March	1	0	1	0.0
April	2	0	0	0.1
Total	1840	370	2210	

7.2 Size

Sampling of individual eels (n = 481) gave an average length of 44.4 cm (range: 30.6 – 91.2cm) and an average weight of 177g (Table 7.2) and the proportion of male eels was 35.1%. The length frequency is presented in Figure 7.2 along with those for 2015 and 2016 for comparison. The lack of eels above 46/47cm was notable.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4,400, fell to 2,200 between 1983 and 1989 and increased again to above 3,000 in the '90s (Fig. 7.3). There was an above average count in 1995, possibly contributed to by the exceptionally warm summer. The count in 2001 of 3875 eel was the second highest recorded since 1982. The average weight of the eels in the samples has been steadily increasing from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Fig. 7.3). The annual count and average weight in 2010 and 2011 were both below the mean for the last decade.

In 2012, the majority of the eel run was sampled (n=3317; 99.5%). The run increased from 1969 in 2011 to 3335 in 2012 and the average weight decreased from 180 to 163.5g. The sex ratio changed from 24% to 45% over the past five years. Male eels have remained the same length over the past 15 years (36cm) whereas the females have changed from 53cm (1997-2005) to 50cm (2008-2012).

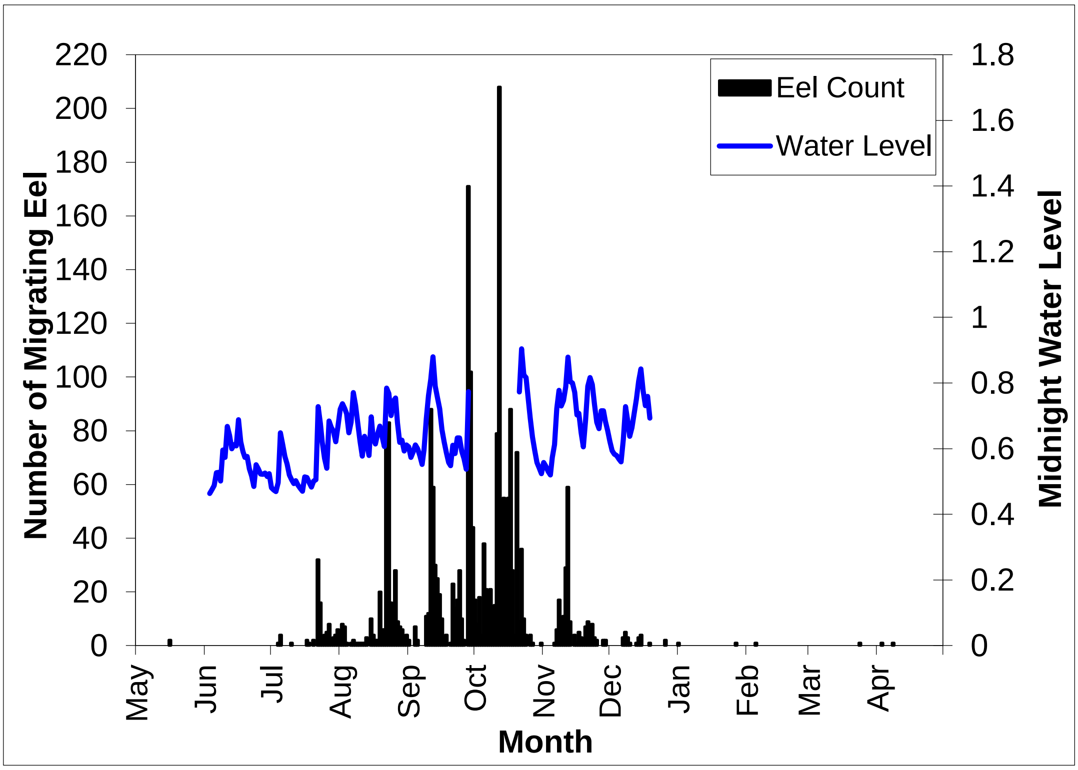

Figure 7-1: Daily counts of downstream migrating silver eel and mid-night water levels (m), May 2017 to April 2018.

Table 7-2: Comparative data for the silver eel runs since 1971.

Years	Number Sampled	Mean. Weight (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1991 - '95	3441	227
1996 - '00	3958	212
2001 - '05	3201	215
2006	493	225
2007	571	201
2008	796	234
2009	220	209
2010	982	192
2011	1835	180
2012	3315	163
2013	1301	157
2014	650	196
2015	366	192
2016	554	177
2017	481	177

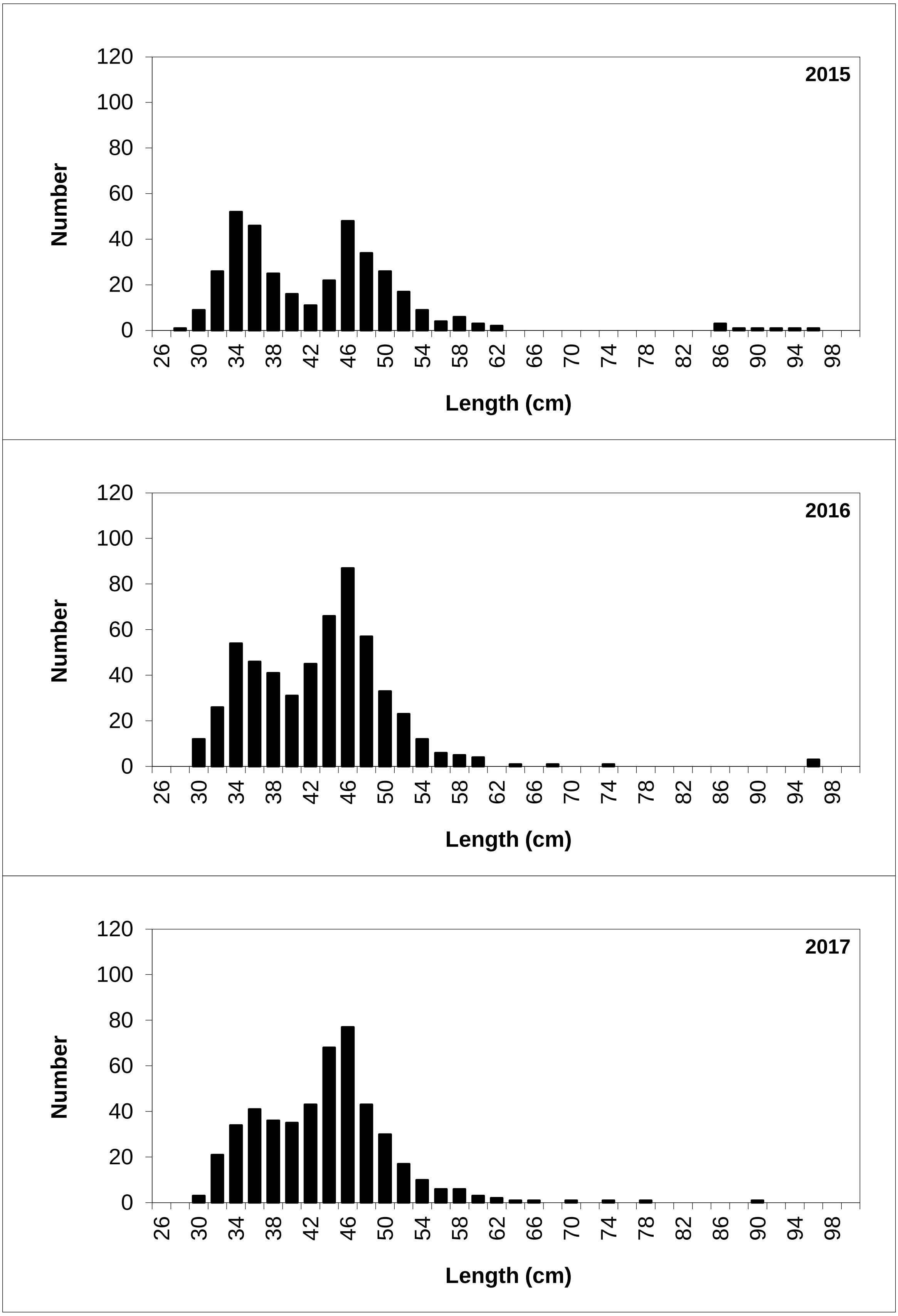

Figure 7-2: Length frequency of sub-samples of silver eels trapped in the downstream traps, 2015 (n=365), 2016 (n=554) and 2017 (n=481). Note change of y-axis scales.

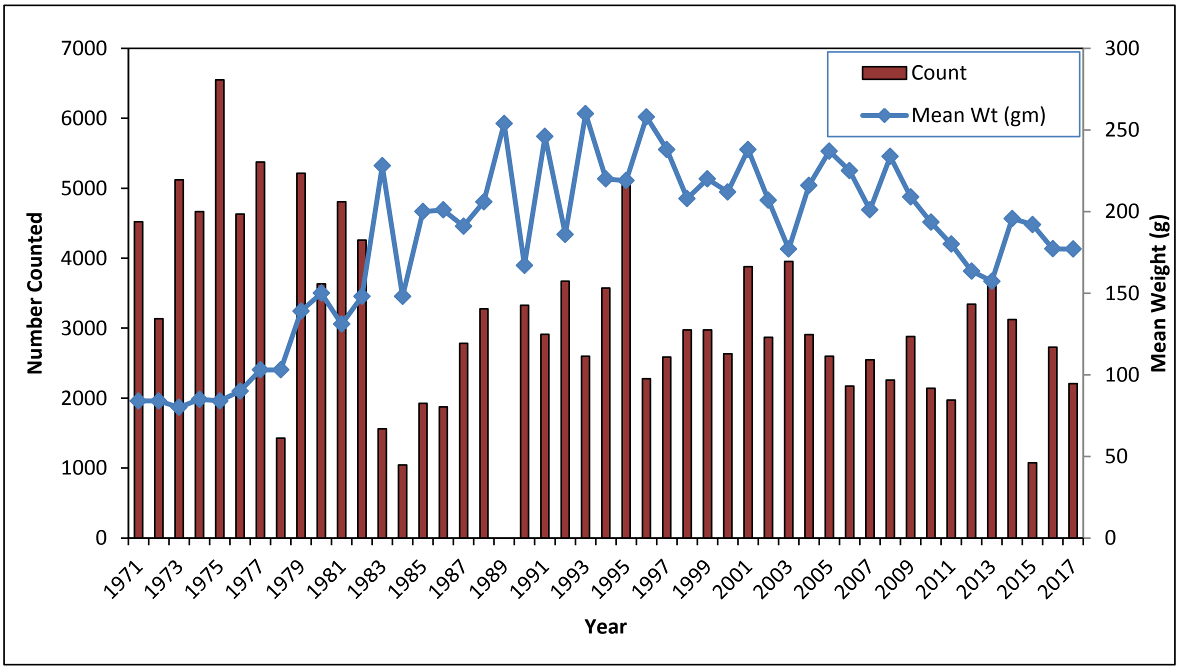

Figure 7-3: Annual number and mean weight of silver eels trapped in the downstream traps.

8 Fishery Report - Catch Data

The Burrishoole Fishery is a valuable part of the overall stock census programme and is run as an integral part of the monitoring programme. As part of the conservation of the Burrishoole wild stock, changes to the active season and to the parts of the catchment being fished have caused differences, or gaps, in the data being collected. Lough Feeagh, which had been closed to angling since 1997 for conservation reasons was opened to angling for the month of September in 2008, on a catch and release basis for wild fish. In 2009 - 2013 Lough Feeagh was open for angling on a catch and release basis from August to the end of September and in 2014 for one week only from 24th August due to low stock. In 2015 Lough Feeagh was open from August 12th to the end of September and Lough Furnace was open to angling from 17th of June to the 30th September. The fishery was operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout. During 2016 Lough Furnace was open from June 15th to September 30th. Lough Feeagh was open from 17th August to the end of September. The fishery was again operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout.

During 2017 Lough Furnace was open from June 14th to September 30th. Lough Feeagh was closed under a conservation byelaw. The fishery was again operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout.

8.1 Numbers and Average weight of Rod Catch

The Lough Furnace rod catch in 2017 consisted of 12 wild fish and 57 reared fish. All wild caught fish were returned alive.

The average weight of reared fish was 1.7kg (n = 57) and the heaviest fish was 2.7kg. No lengths or weights are available for wild fish due to catch & release being in place.

A total of 6 sea trout were caught on Lough Furnace. Regulations remained in place whereby all rod caught sea trout were returned alive.

There was no angling on L. Feeagh in 2017 for either sea trout or salmon.

8.2 Timing of Catch and Rod Effort

Angling conditions were generally good during 2017 with rainfall during most weeks. The main feature of the season was the poor wild salmon catch and the fact that the first wild fish was not caught until July 1st. As in the previous two years, there was a low catch of wild fish (12) in Furnace and this was again attributed to the general high flow rates during the season which resulted in fish running through Lough Furnace rather than staying in the lake.

Table 8-1: Wild and reared salmon rod catch and rod effort (hours) for the 2017 season for L. Furnace and L. Feeagh.

Furnace

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	9	174
July	8	40	852.5
August	4	8	368
September	0	0	24
Total	12	57	1818.5

Feeagh

Lake Closed

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
Total	0	0	0

8.3 Exploitation Rates of Rod Fishery

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2. From 1997 onwards Lough Feeagh was closed to angling. Exploitation rates are only available for Lough Furnace since 1997. The cessation of angling on Lough Feeagh was due to the continuing low stock level of wild fish. Following the cessation of drift netting in 2007 and the increased return of wild fish it was decided to re-open Lough Feeagh in 2008 to angling for the month of September only on a catch and release basis for both wild and ranched fish. Since 2008, and in future years, the running of a fishery on L. Feeagh was reviewed each year and was dependent on sufficient wild stock being present. In 2017 Lough Feeagh was closed to angling as the stock was below the limit permitted for Catch & Release.

No sea trout angling was permitted on L. Feeagh between 1997 and 2008 and since 2008 up to 2016 the fishery has been open on a limited basis. In 2017 sea trout angling was not permitted.

Anglers fishing on Lough Furnace were requested to return wild salmon alive to the water. Injured or damaged wild fish were permitted to be retained however no fish were retained in 2017.

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2010 to 2017 are shown in Table 8.2.

Table 8-2: Rod fishing exploitation rates (2010-2017). [1] based on total catch; [2] based on catch killed.

	2010	2011	2012	2013	2014	2015	2016	2017
WILD SALMON								
Lough Feeagh								
"Available" fish by end of fishing season	691	516	683	694	145	632	461	*
Total rod catch	8	13	28	16	0	19	12	
Rod catch retained	0	0	0	0	0	0	0	
Angling success %[1]	1.15	2.5	4.10	2.31	0.00	3	2.6	
Exploitation rate %[2]	0	0	0	0	0	0	0	
WILD SALMON	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Loughs Feeagh & Furnace								
Total stock of wild fish	703	571	686	734	305	650	548	541
+ 10% addition for L. Furnace population	773	628	755	807	336	715	602	595
Total catch of wild fish	26	36	50	35	8	28	17	12
Rod catch retained	0	0	0	1	0	0	0	0
Max. angling success %	3.7	6.3	7.3	4.8	2.6	3.9	3.1	2.2
Min. exploitation rate	0	0	0	0.1	0	0	0	0
Max. exploitation rate	0	0	0	0.1	0	0	0	0
REARED SALMON	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Lough Feeagh								
"Available" fish by end of fishing season	130	125	128	105	117	101	109	*
Total rod catch	1	1	3	1	0	2	3	
Rod catch retained	0	0	0	0	0	0	0	
Angling success %[1]	0.8	0.8	1.5	1.0	0.0	2	1.5	
Exploitation rate %[2]	0	0	0	0	0	0	0	
Loughs Feeagh & Furnace								
Total stock	940	1293	2392	1301	1205	1931**	1245	1212
Total rod catch	79	86	78	71	40	25	47	57
Exploitation rate %	8.4	6.7	3.3	5.5	3.3	1.3	3.8	3.3
WILD SEA TROUT	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Lough Feeagh								
"Available" fish by end of fishing season	71	58	129	60	140	58	80	*
Rod catch	1	1	5	12	19	30	28	
Exploitation rate %	0	0	0	0	0	0	0	
Angling Success %	1.4	1.7	3.9	20.0	13.6	51.7	35.0	

* Fishery closed; ** due to the flooding issue in November & December, this figure is based on the total return of reared fish processed for tags

8.4 Angling Success

Table 8.3 presents the Catch per unit effort (CPUE) which is the number of fish caught per rod day, and the Effort per unit catch (EUPC) which is the number of rod days it takes to catch a fish.

Table 8-3: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery based on an eight hour fishing day. Salmon includes both wild and reared.

	Lough Furnace				Lough Feeagh			
	Salmon		Sea Trout		Salmon		Sea Trout	
Year	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
'80-'84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
'85-'89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
'90-'95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
'96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90
'97	0.17	6.00	0.10	9.60	*	*	*	*
'98	0.44	2.30	0.08	13.20	*	*	*	*
'99	0.09	10.80	0.05	20.80	*	*	*	*
'00	0.30	3.31	0.06	16.50	*	*	*	*
'01	0.15	6.70	0.12	8.40	*	*	*	*
'02	0.12	8.30	0.07	15.30	*	*	*	*
'03	0.13	7.60	0.06	17.70	*	*	*	*
'04	0.22	4.60	0.16	6.30	*	*	*	*
'05	0.26	3.80	0.08	13.00	*	*	*	*
'06	0.44	2.30	0.04	23.50	*	*	*	*
'07	0.49	2.10	0.14	6.90	*	*	*	*
'08	0.35	2.89	0.05	21.60	0.46	2.18	0.07	13.80
'09	0.18	5.66	0.24	4.09	0.21	4.75	0.42	2.38
'10	0.60	1.66	0.14	7.27	0.82	1.22	0.09	11.00
'11	0.68	1.47	0.35	2.8	1.06	0.95	0.08	13.10
'12	0.96	1.04	0.10	10.10	1.10	0.91	0.18	56.62
'13	0.66	1.51	0.22	4.5	0.60	1.70	0.42	2.40
'14	0.32	3.17	0.35	2.9	0.00	0.00	0.18	5.60
'15	0.23	4.31	0.17	5.75	0.40	2.50	0.56	1.77
'16	0.31	3.18	0.13	7.41	0.38	2.6	0.72	1.4
'17	0.39	2.57	0.03	29.5	*	*	*	*

9 Catchment Stock Assessment

9.1 Introduction

The Burrishoole catchment, upstream of the main fish traps, has been monitored since 1990 with surveys of the salmonid and eels stocks taking place in the rivers and the main lakes. Electrofishing, with 3-fishing depletions, is used for salmonids and eels in the streams, fine mesh beach seines are used for salmonids in the lakes and summer fyke nets are used for eels in the lakes. Eel surveys are also undertaken in the tidal waters below the traps.

9.2 Electrofishing Surveys

2017 marked the completion of 27 years of electrofishing surveys in the Burrishoole and Owengarve catchments. Densities of eels and juvenile salmonids were calculated using three pass removal sampling.

In 2017, poor weather conditions again severely hampered our efforts at a catchment wide survey, and only 20 sites in the Burrishoole were fished in total. None of the larger sites were fishable, owing to high water levels throughout August and September. Sites were fished between the 25th July and the 26th September. 1242 fish were caught and measured over the 20 sites, although it should be noted that five of the Rough river sites (1-5) were stocked for experimental purposes and should not be considered as part of natural stock recruitment. The 20 sites comprised 2041m^2 of representative habitat. Summary data are presented in Figures 10.1-10.6, and these show the distribution of fish densities around the catchment for eel (Fig. 10.1), 0+ salmon (Fig. 10.2), 1+ salmon (Fig. 10.3), 0+ trout (Fig. 10.4), 1+ trout (Fig. 10.5) and 2+ trout (Fig. 10.6).

The average eel density was 0.007 fish/m^2, with eels recorded in 8 sites out of 20.

Average density of 0+ salmon was 0.23 fish/m^2, with catches recorded in 12 sites. However, 5 of these sites (Rough river 1-5) were stocked for experimental purposes, and when these are excluded, the average density is 0.18 fish/m^2. 1+ salmon were also recorded in 11 sites, with an average density of 0.08 fish/m^2. It should be noted that of the 13 sites fished, 8 would be either inaccessible or inhospitable to salmon.

Average densities of 0+, 1+ and 2+ trout were 0.34, 0.11 and 0.01 fish/m^2 respectively. As with 0+salmon, 0+ trout were also stocked in the rough river, between the trap and the water fall, and without these sites, the average 0+ trout density in the remaining 15 sites was 0.34 fish/m^2 . 0+ and 1+ trout were recorded in all 20 sites, while 2+ trout were recorded in 14sites respectively.

Average densities of trout were similar to those recorded in previous years. (Fig.10.7).The density of 0+ salmon was lower, but this is expected, as it does not include the productive stretch of the rough river. The density of eel was lower than the previous years.

9.3 Beach Seine Surveys

Beach seine surveys were conducted in 2017 (Plate 1) and were also incorporated into a Cullen PhD on juvenile salmonids (Ross Finlay). Five or six sites on Bunaveela Lough were fished on three occasions, 21/6, 16/8 and 26/10 and on Lough Feeagh on the 23/6, 21/8 and 27/10. Table 9.1 gives the details of the numbers of fish captured, tagged and recaptured for each fishing date. Two char were also captured, PIT tagged and released.

Table 9-1: Summary data for the 2017 beach seine surveys.

Date	Site	No. of Hauls	Trout Tagged	Trout below Tag Size (70mm)	Trout Recap	Salmon Tagged	Salmon Below Tag Size (70mm)	Salmon Recap	Char Tagged
21/06	Bunaveela	5	147	13	1	29	5	0	0
23/06	Feeagh	5	71	0	1	80	1	4	0
16/08	Bunaveela	6	103	15	14	20	2	1	2
21/08	Feeagh	6	52	0	17	28	3	21	0
26/10	Bunaveela	6	122	11	19	21	5	1	0
27/10	Feeagh	6	31	0	12	11	0	9	0

Plate 1. Beach seining on Lough Feeagh

9.4 Fyke Net Surveys

9.4.1 Survey Data

Fyke net surveys of yellow eels have been conducted in the 1970s and 1980s as parts of previous studies. The Burrishoole lakes Feeagh and Bunaveela have been incorporated into the National Eel Survey in 2009-2017. Fyke net surveys of the tidal Lough Furnace and 'Back of the House' have been more sporadic or at a lower effort.

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year.

Fyke net surveys carried out between 1960 and 2008 will provide a useful bench mark against which to assess the changes in stock. The yellow eel monitoring strategy will rely on the use of standard fyke nets. Relative density will be established based on catch per unit effort.

Bunaveela Lough is located in the upper reaches of the catchment. It has a surface area of 42ha and a maximum depth of 23m. Bunaveela L. was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2017 (18 July 2017), with chains of 10 nets fished at three sites. In total eight eels were caught with a catch per unit of effort of 0.27 eels/net/night (Table 9.2). The average length was 48.1cm and ranged in length from 40.4cm to 59.5cm. Eight eels were PIT tagged and no recaptures were made of previously tagged fish.

Lough Feeagh has a surface area of 395ha and an average depth of 14.5m (with several areas >35m in depth). L. Feeagh was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2017 (11-12 July 2017), with chains of 10 nets fished at six sites for one night each. In total, 40 eels were caught with a catch per unit effort (CPUE) of 0.67 eels/net/night (Table 9.2). The average length of eels was 43.4cm and ranged in length from 31.3cm to 59.9cm, with a total weight of 6.130 kg caught in the two nights. Most of the catch (34) was PIT tagged and one previously tagged eel was recorded. Six eels were sacrificed in this survey. Four of the six (66.7%) of the eels contained *A. crassus* with an infection intensity of 6.8. This is the first recording of *A. crassus* in yellow eels in freshwater in Burrishoole.

Lough Furnace, the tidal lough, has a surface area of 125ha north of Nixon's Island and 16ha between Nixon's Island and the mouth of the estuarine river (Lower Lough Furnace). The main lough has a maximum depth of 21.5m. Furnace is heavily stratified with significant areas of deoxygenated water in the main basin. L. Furnace was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2017 (20-21 July 2017), with chains of 10 nets fished at six sites in one night each and one night (7 July 2017) with two chains of nets at the Back of the House, which is a shallow tidal area between the lough and the estuarine river.

In L. Furnace, only 9 eels were caught with a catch per unit effort (CPUE) of 0.15 eels/net/night (Table 9.2). The average length was 46.4cm and ranged in length from 33.9cm to 71.1cm. A total weight of 1.83kg was caught.

In the Lower Lough Furnace, only 9 eels were caught with a catch per unit effort (CPUE) of 0.45 eels/net/night (Table 9.2). The eels average length was 40.7cm and ranged in length from 33.1cm to 52.9cm, with a total weight of 1.01 kg caught.

The catches in the 2017 survey were particularly poor and the absence of large eels was notable. In 2017, large inundations of jelly fish caused problems with the survey. The impact on the eel stock of huge densities of jellyfish on the bottom on the eel stock is unknown.

Six eels were sacrificed in this survey form Lough Furnace. Four of the six (66.7%) of the eels contained *A. crassus* with an infection intensity of 20.8. *A. crassus* has been established in the lough since about 2011.

Table 9-2: Catch details of the standard yellow eel survey in 2017. Net (pair of traps).

Lake	Dates	No. Eels	Net* Nights	CPUE	Total weight (kg)	Mean length (cm)	Mean weight (Kg)
Bunaveela	18/07/2017	8	30	0.27	1.62	48.1 (40.4-59.5)	0.203
	2017	**8**	**30**	**0.27**	**1.62**	**48.1 (40.4-59.5)**	**0.203**
Feeagh	11/07/2017	22	30	0.73	3.35	42.7 (32.2-59.9)	0.152
	12/07/2017	18	30	0.60	2.78	44.2 (31.3-57.0)	0.154
	2017	**40**	**60**	**0.67**	**6.13**	**43.4 (31.3-59.9)**	**0.153**
Furnace	20/07/2017	5	30	0.17	0.93	46.5 (36.2-58.1)	0.185
	21/07/2017	4	30	0.13	0.91	46.3 (33.9-71.1)	0.226
	2017	**9**	**60**	**0.15**	**1.84**	**46.4 (33.9-71.1)**	**0.123**
BOH	07/07/2017	9	20	0.45	1.01	40.7 (33.1-52.9)	0.112
	2017	**9**	**20**	**0.45**	**1.01**	**40.7 (33.1-52.9)**	**0.112**

9.4.2 Quantitative Eel Survey

A pilot quantitative eel net survey was commenced in 2015 with sites being selected in Bunaveela (1), Feeagh (2) and Furnace (2). These sites were fished again in 2016 and 2017. The aim of the study is to investigate whether eel survey data from fyke nets can be used to predict annual silver eel escapement by comparing the yellow eel data with the silver eel output from the traps. This has relevance to silver eel output modelling (i.e. EDA) for reporting to the EU.

9.4.3 *Anguillicola crassus*

Anguillicola crassus is an indigenous parasitic nematode of the Japanese eel *Anguilla japonica* in Asia. *A. crassus* does not cause serious pathological damage in its natural host. However, infections in European eel are potentially more serious and can cause damage to the swimbladder with associated bacterial damage, red and swollen anus, as well as, in most severe cases, the collapse of the swimbladder lumen.

A. crassus was introduced into Europe in the early 1980s and it has since spread widely and has successfully colonized most European countries. It was first recorded in Ireland (Waterford Harbour) in 1997. Later records came from the Erne catchment in 1998 and it is now present in approximately 74% of the wetted area of Ireland. The most likely infective route to Ireland was the commercial eel trade although localised spread can be through natural eel movements and paratenic hosts.

The Burrishoole catchment remained free of the parasite until recently. In the fyke net survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus*. Samples of yellow eels from L. Feeagh were negative and a comprehensive sample of silver eels from the traps was also negative indicating that in 2012 the infection seemed to be confined to the tidal lough. This was somewhat surprising as a number of environmental factors have been shown to influence *A. crassus* infections. High salinity has been shown as having a negative impact in the egg hatching and larvae survival of the parasite although the effects of water salinity remain unclear as various surveys have shown no differences in infection levels in waters with different salinity values.

Examination of previous samples would indicate that the parasite was likely to have been introduced into L. Furnace in 2010 or early 2011 (Table 9.3).

The infection intensity in L. Furnace eels continued to rise in 2014 and it was also detected in yellow eels in the Mill Race channel in 2014. The prevalence in 2017 remained at 67% although the intensity increased to 20.7.

The first detection in freshwater was made in 2016 with 10 silver eels (36%) migrating out of the catchment containing the parasite (Table 9.3).

In 2017, the infection had increased to 67% in Lough Feeagh and 65% in the out-migrating silver eels, which had an intensity of 7.2

9.5 Long-term biological monitoring in the Burrishoole catchment

Macroinvertebrate surveys of 16 index sites were conducted in 2017. 874 individuals from 48 samples were counted and identified, and are recorded in the Catchment Macroinvertebrate Access database for future analysis. Zooplankton and phytoplankton surveys of Feeagh and Furnace were continued in 2017, with monthly samples being collected using standard methods, and preserved for future enumeration and identification.

Table 9-3: Location and sample details for eels in Burrishoole examined for the presence of *Anguillicola crassus*.

Year	Location	No. of eels checked	Stage	No. Infected	Prevalence	Intensity
Freshwater						
2009	Traps	50	Silver	0	0	0
2010	Yellow R.	5	Yellow	0	0	0
2010	Black Lakes	3	Yellow	0	0	0
2010	Glenamong R.	3	Yellow	0	0	0
2010	Feeagh	2	Yellow	0	0	0
2010	Traps	17	Silver	0	0	0
2011	Traps	50	Silver	0	0	0
2011	Feeagh	30	Yellow	0	0	0
2012	Feeagh	4	Yellow	0	0	0
2012	Traps	168	Silver	0	0	0
2013	Traps	106	Silver	0	0	0
2014	Traps	94	Silver	0	0	0
2014	Mill Race Lwr	7	Yellow	4	57.1	2.3
2014	Mill Race Uppr	11	Yellow	2	18.2	1.0
2015	Traps	10	Silver	0	0.0	0.0
2016	Traps	28	Silver	10	35.7	2.0
2017	Feeagh	6	Yellow	4	66.7	2.5
2017	Traps	26	Silver	17	65.4	7.2
Saline Water						
2008	Furnace	60	Yellow	0	0	0
2009	Fu Nixons	47	Silver	0	0	0
2010	Furnace	10	Yellow	0	0	0
2010	Fu Nixons	50	Silver	0	0	0
2011	Furnace	4	Yellow	2	50	1.0
2012	BOH	6	Yellow	6	100	2.0
2012	Furnace	10	Yellow	7	70	4.4
2013	Furnace	6	Yellow	6	100	13.5
2014	Furnace	9	Yellow	5	56	17.6
2016	Furnace	12	Yellow	8	67	2.7
2017	Furnace	6	Yellow	4	66.7	20.7

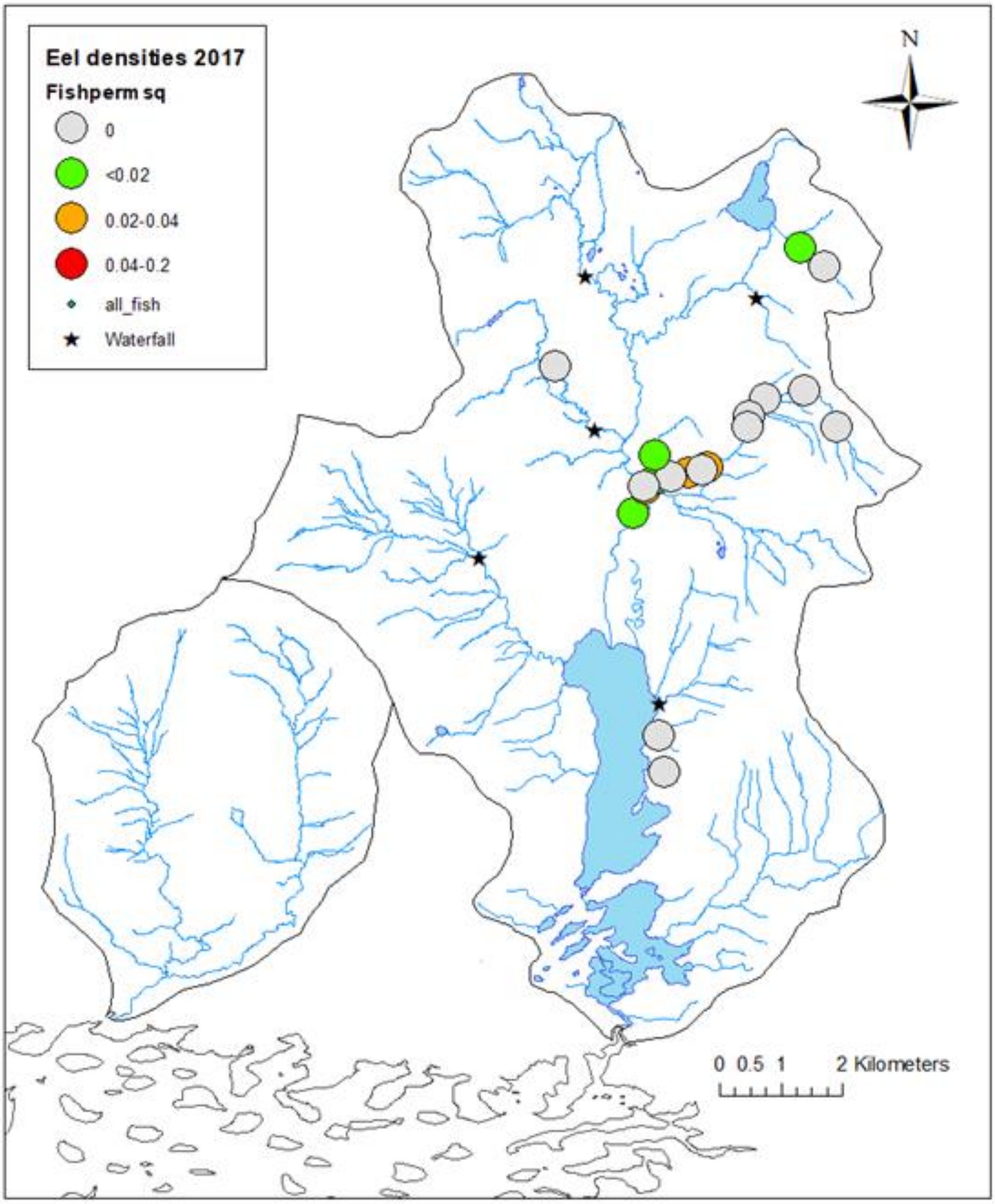

Figure 9-1: Densities of eel calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

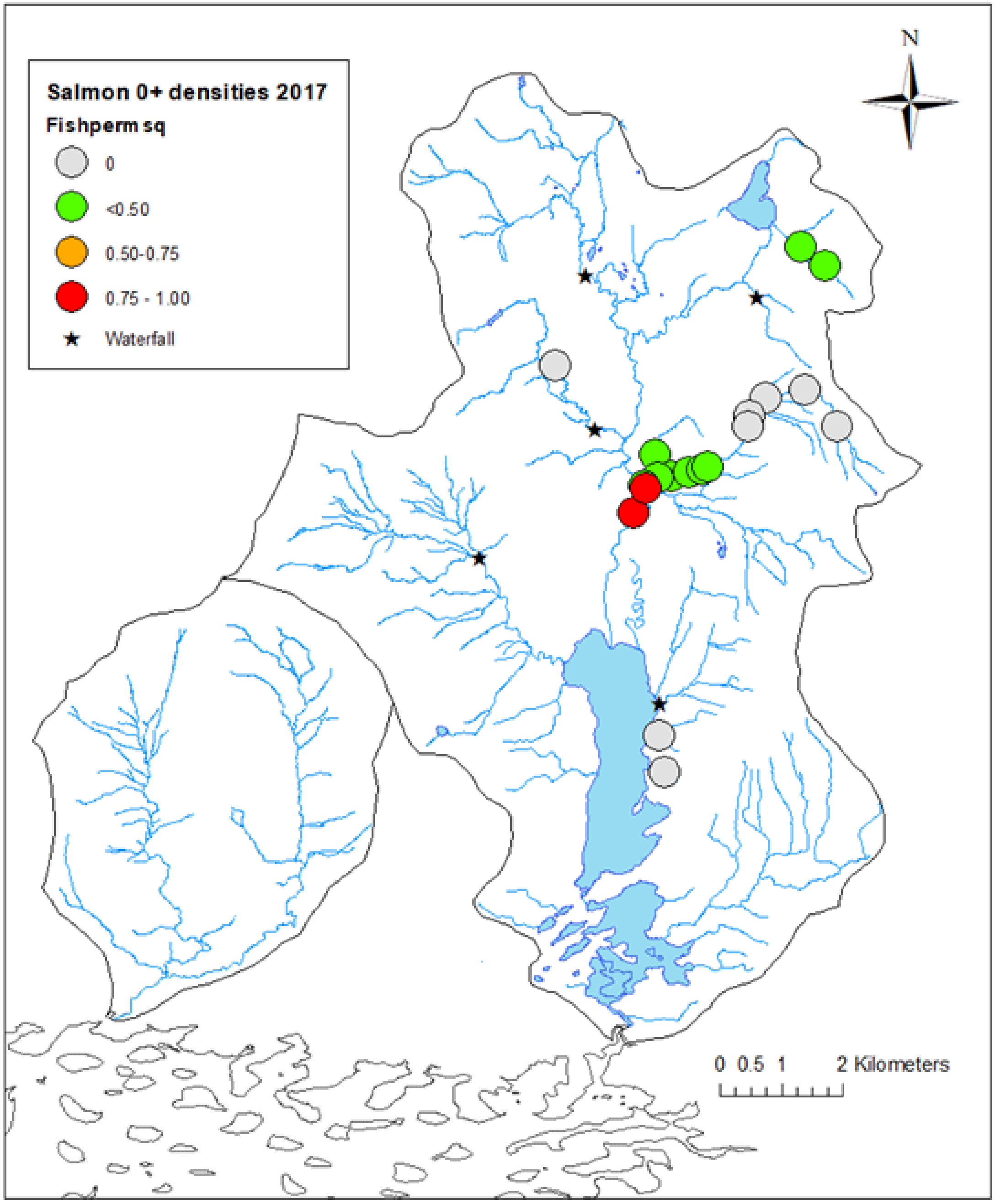

Figure 9-2: Densities of 0+ salmon calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

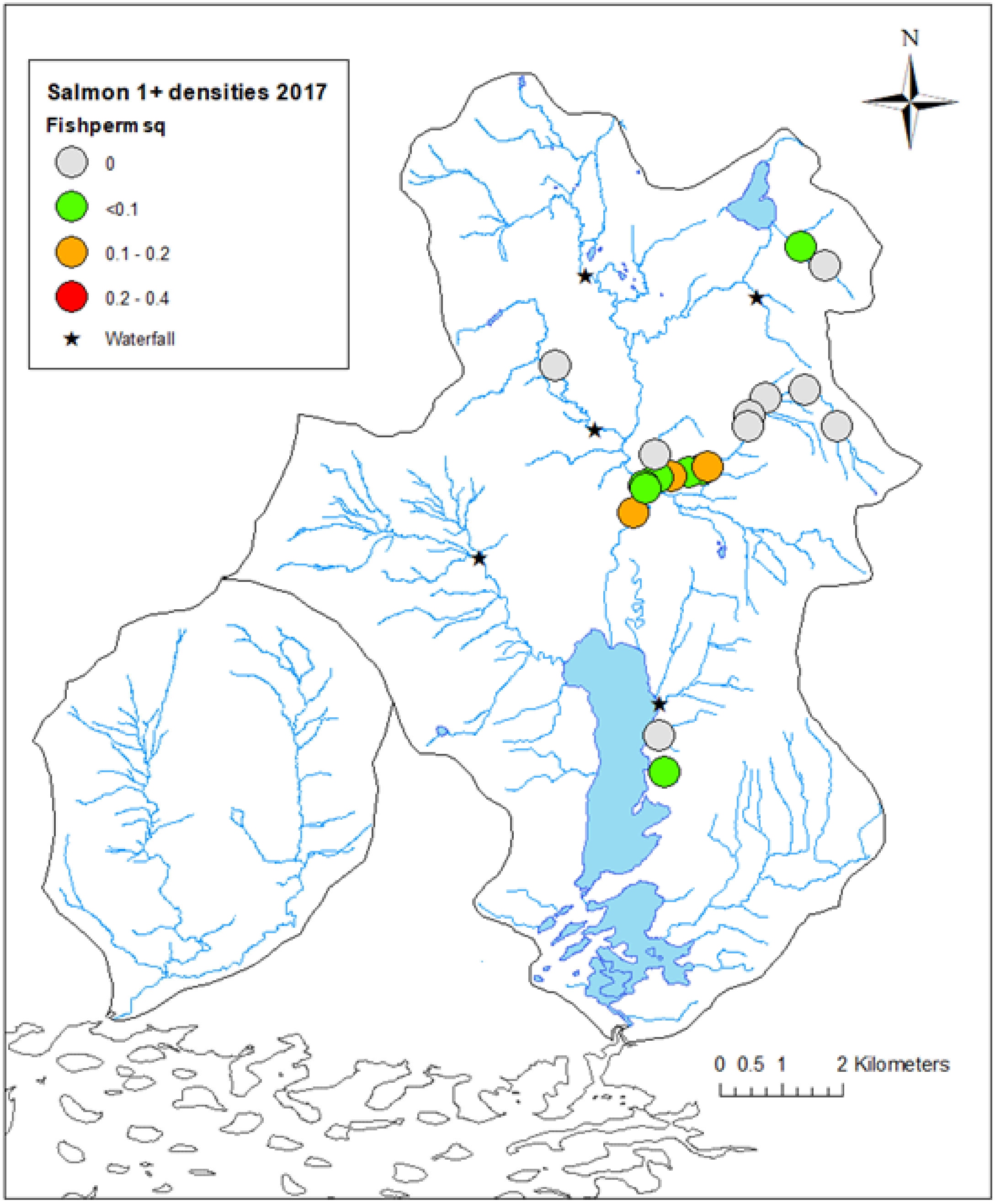

Figure 9-3: Densities of 1+ salmon calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

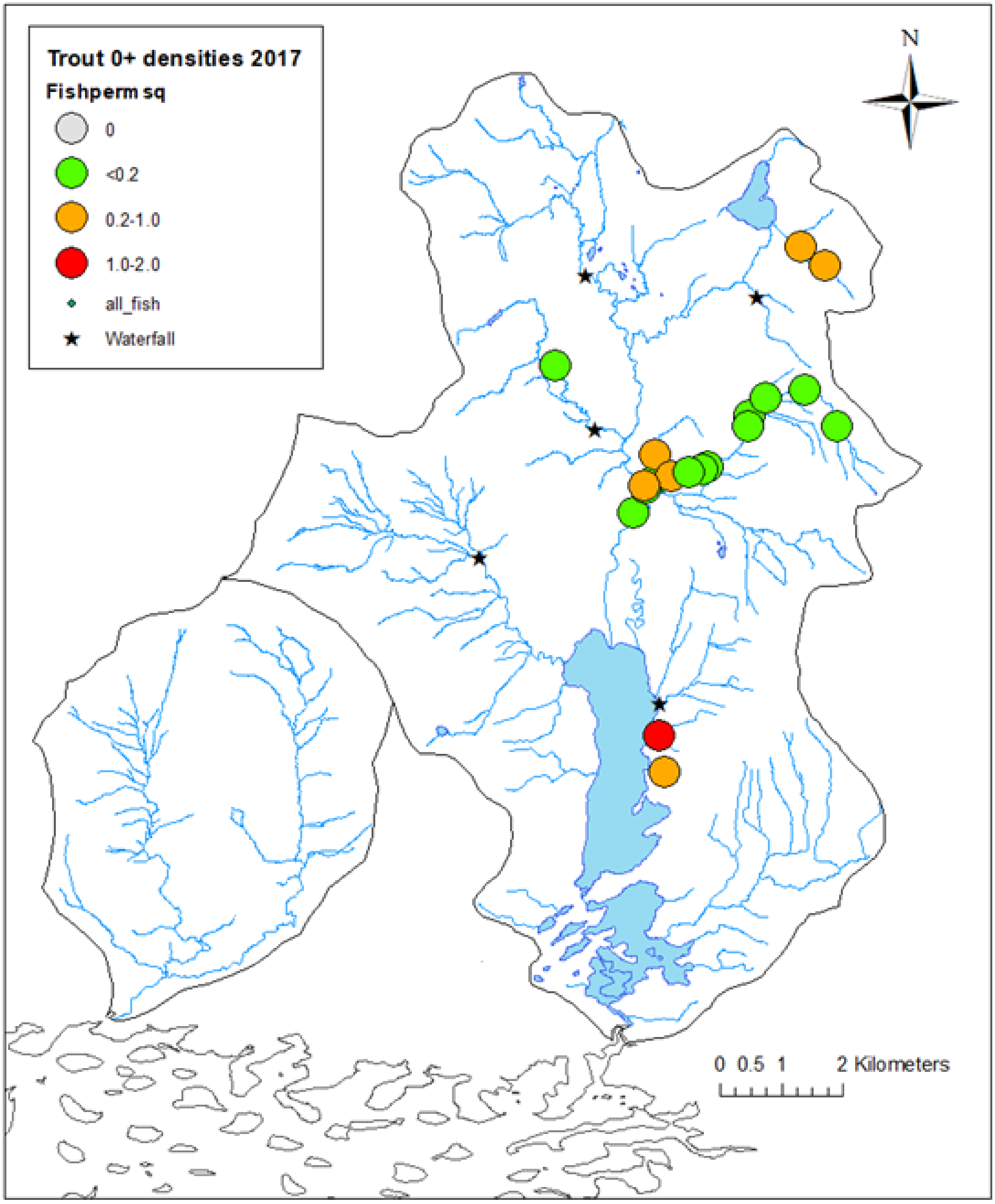

Figure 9-4: Densities of 0+ trout calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

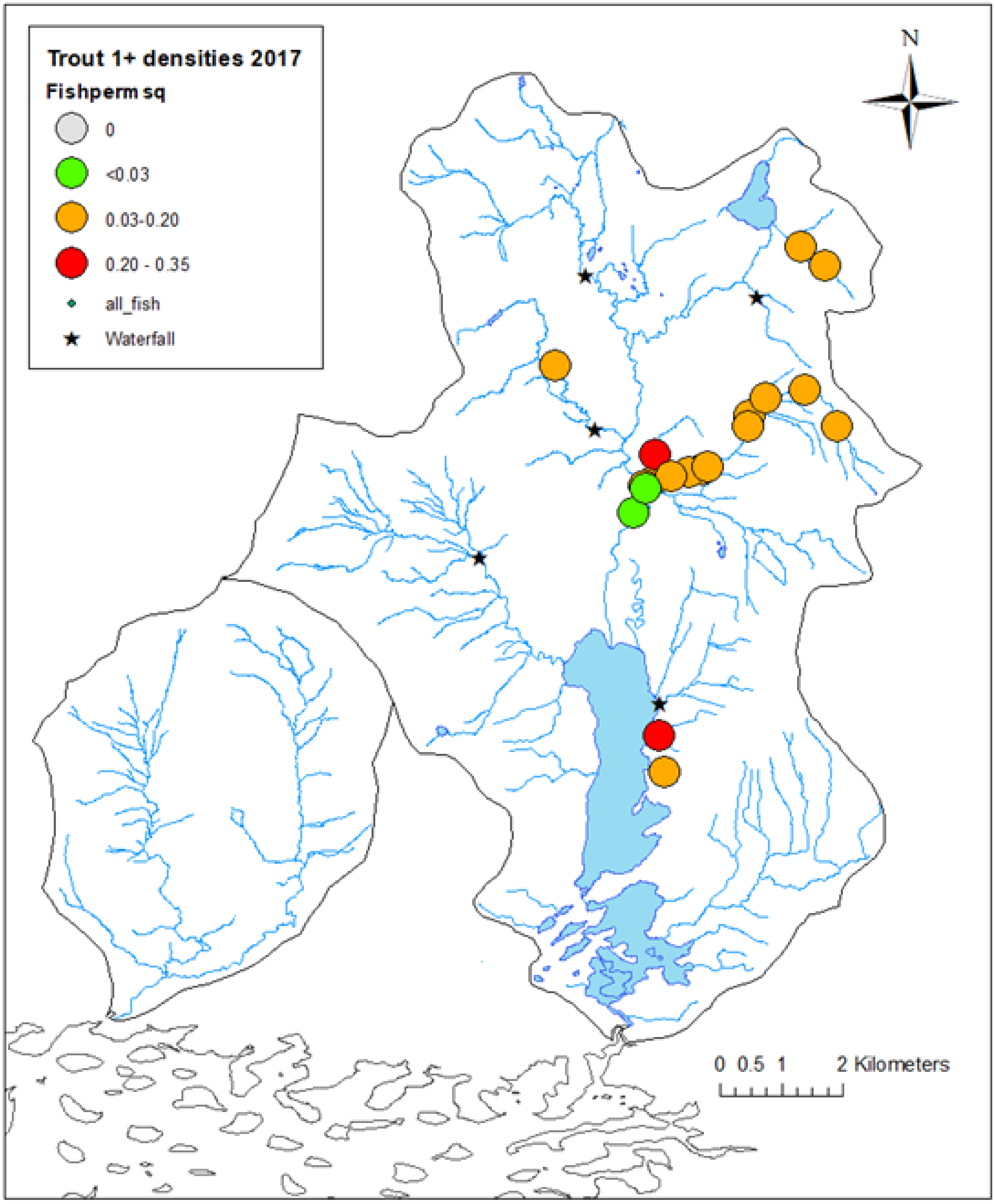

Figure 9-5: Densities of 1+ trout calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

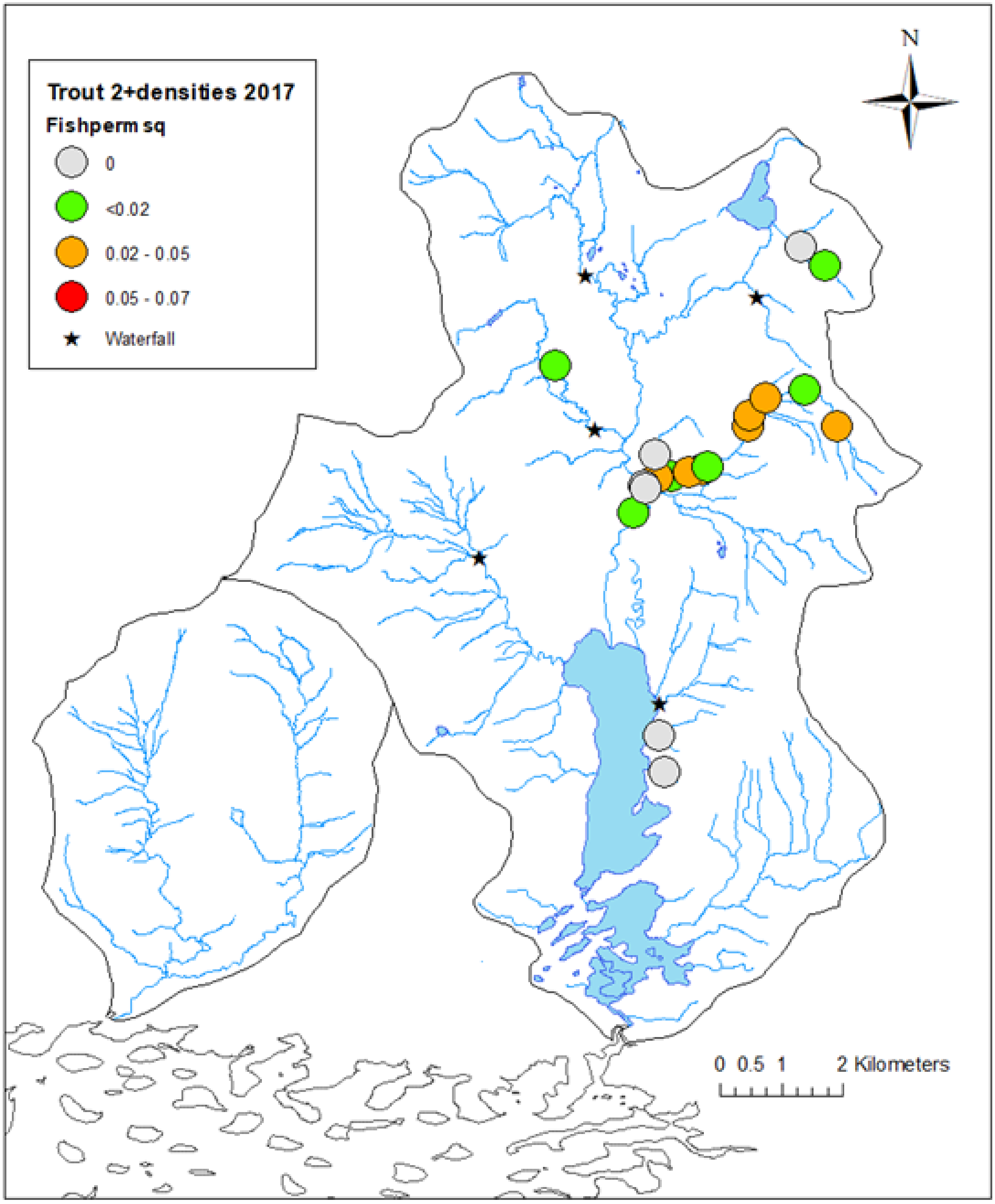

Figure 9-6: Densities of 2+ trout calculated from the 2017 electrofishing survey of the Burrishoole and Owengarve catchments.

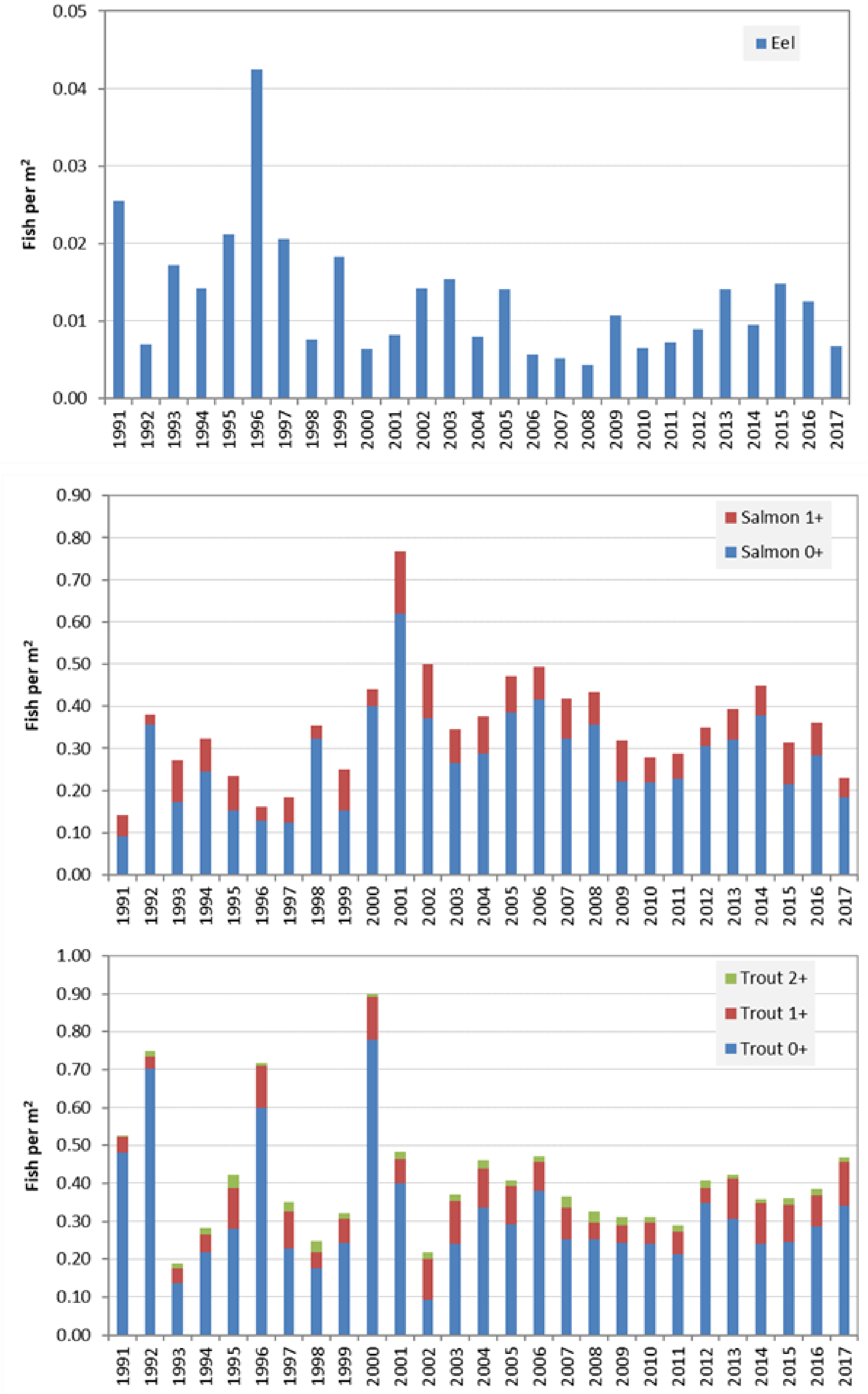

Figure 9-7: Average densities of eel, salmon and trout (fish per m²) calculated from electrofishing surveys of the Burrishoole and Owengarve catchments, 1991-2017. Note that the values for 0+salmon and trout do not include densities from the Rough river, sites 1-5 as these were stocked heavily for experimental purposes.

10 Collaborative Research Programme

10.1 GLEON

In 2007, the Burrishoole catchment became a member of the Global Lake Ecological Observatory Network (GLEON: http://www.gleon.org), an association of limnologists, information technology experts and engineers whose goal is to establish a persistent network of lake ecology observatories (http://www.gleon.org). Work with GLEON working groups continued in 2017, and the Marine Institute was represented at GLEON 19 in New York state by Elvira de Eyto. There was a large Irish contingent at the meeting (Fig. 10.1), representing the many diverse collaborative projects we are involved in. Data from the Burrishoole catchment are being used in several GLEON working groups, including those focussed on signal processing of high frequency lake data, the role of catchment processes and dynamics on lake metabolism and the role of lakes in the global carbon cycle. Elvira de Eyto served her second or three years on the steering committee.

Figure 10-1: Irish researchers attending GLEON 19 in New York, November 2017. Back (L-R): Mikkel Andersen (DkIT), Ewan Geffroy (DkIT), Sean Kelly (NUIG and MI), Maria Caldero (DkIT), Tadhg Moore (DkIT). Front (L-R) Elizabeth Ryder (UCC and MI), Valerie McCarthy (DkIT) Elvira de Eyto (MI) and Eleanor Jennings (DkIT) .

10.2 Cullen PhD Fellowships

In 2015, a call was put out for four PhD fellowships to be awarded for projects based in Burrishoole. Sean Kelly commenced his project in October 2015, and three others started in 2016.

The projects are as follows:

Brian Doyle (E. Jennings, DKIT): Resolving the Organic Carbon Budget of a salmonid humic lake.

Sean Kelly (M. White, NUIG): To investigate the dual influence of marine water and freshwater on the hydrography and related ecology of a coastal lagoon, Lough Furnace, Co. Mayo.

Aisling Doogan (D. Brophy, GMIT): Investigation of the causes of early migration mortality in salmon and sea trout from the Burrishoole National Index River using acoustic telemetry in freshwater and coastal areas.

Ross Finlay (T. Reed, UCC): Investigation of the early migration of salmon and brown trout from the Burrishoole National Index River using PIT tag technology in freshwater and brackish areas

By the end of 2017, all four projects were progressing as planned.

10.3 PROGNOS

In 2016, we commenced the PROGNOS project, which is financed under the ERA-NET Cofund WaterWorks2014 Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI). Irish funding to the two partners (Marine institute and Dundalk IT) comes from the EPA. In PROGNOS, we are developing an integrated approach that couples high frequency (HF) lake monitoring data to dynamic water quality models to forecast short-term changes in nuisance algal blooms and higher levels of dissolved organic carbon (DOC). This will potentially provide a greater window of opportunity over which to make water quality management decisions, and will increase the value of HF monitoring data, ensuring that their potential to guide water quality management is fully realised. The project consortium includes expertise from European sites that have been involved in the forefront of HF monitoring systems since the late 1990s, expertise in modelling algal blooms and DOC levels, and expertise in assessing societal benefits from changes in water management. Lough Feeagh will be used as a DOC case study. Tadhg Moore continued his PhD with the project team, registered in DkIT under the supervision of Eleanor Jennings (DkIT) and Elvira de Eyto (MI), and has made significant progress in 2017 collating many years of high frequency data from the catchment and modelling the physical structure of Lough Feeagh. The second annual PROGNOS meeting was held in NIVA, Oslo in June 2017. More information can be found on the PROGNOS website (http://prognoswater.org/), including an informative blog section.

10.4 DETECT

DETECT is an Environmental Protection Agency funded project that aims to develop an Assessment Framework to support the identification of the principle stressors constraining ecological recovery in water bodies. The MI is a partner in the project, with a small role providing data from the long term ecological monitoring of the Burrishoole catchment. The project started in February 2016 and runs for four years. One of the key deliverables from the MI will be an analysis of the effects of the July 2009 flood on the Srahrevagh river ecosystem, https://www.afbini.gov.uk/articles/detect-project

10.5 WATExR

In 2017, work began on the WATExR project, which is part of ERA4CS, an ERA-NET initiated by JPI Climate, and funded by MINECO (ES), FORMAS (SE), DLR (DE), EPA (IE), IFD (DK), RNC (NO) with co-funding by the European Union (Grant 690462). It will run from 2017 to 2020. The aim of the project is to integrate state-of-the-art climate seasonal prediction and water quality simulation in a QGIS-based advanced solution to ensure efficient decision making and adaptation of water resources management to an increased frequency of climate extreme events. The project started in September 2017, with a kck-off meeting in ICRA Girona. The MIs role is to conduct the modelling work for the Burrishoole catchment, primarily focussing on using seasonal forecasts to predict fish phenology. A postdoc will start this work in 2018. More information can be found here: https://watexr.weebly.com/

10.6 MANTEL

The Marine Institute is a partner in the MANTEL project which is a Marie Sklodowska-Curie Action . MSCAs provide funding for research-focussed organisations, such as universities, research centres and companies, to host foreign researchers and to create strategic partnerships with leading institutions world-wide. Innovative Training Networks (ITNs) are one area which are funded through MSCAs. ITNs support competitively selected joint research training and/or doctoral programmes implemented by European partnerships of universities, research institutions and non-academic organisations. The aim of ITNs is to boost scientific excellence and business innovation and enhance researcher career prospects through developing their skills in entrepreneurship, creativity and innovation. European Joint Doctorates (EJDs) are one of the three types of ITNs. EJDs require a minimum of three academic organisations to form a network with the aim of delivering joint, double or multiple degrees. The aim of an EJD is to promote international, intersectorial and multi-interdisciplinary collaboration in doctoral training in Europe. In addition to organisations from different EU or associated countries, the participation of additional organisations from anywhere in the world, including from the non-academic sector, is encouraged. This is the role of the Marine Institute, as MANTEL is training a cohort of 12 PhD students, many of whom will use data collected in Burrishoole, and carry out secondments here. MANTEL kicked off in 2017, and recruited throught the year. Most of the students were in aplce by the end of 2017. More information can be found here https://www.mantel-itn.org/.

10.7 Other catchment

During 2017, the catchment team continued collecting samples for inclusion in the GNIR (Global Network of Isotopes in Rivers - http://www-naweb.iaea.org/napc/ih/IHS_resources_gnir.html). GNIR is a global environmental observation programme dedicated to the compilation of isotopic assays of water, nutrients and particulate and dissolved constituents in global river systems. GNIR serves as an essential world-wide repository for riverine isotope data, and facilitates public dissemination of contributed riverine isotopic data through a cost-free user-friendly web portal. GNIR is a complimentary programme to the IAEA (International Atomic Energy Agency) well-established Global Network of Isotopes in Precipitation. Monthly samples are taken from the Black and Mill Race rivers, and dispatched to the IAEA facility in Vienna for analysis.

During 2015, we were involved in another collaborative project CELLDEX, the aim of which was to understand biological degradation across the globe using a standardised protocol. This project is being led by Scott Tiegs of Oakland University, Rochester, United States. Fieldwork for this project was carried out in 2015 and early 2016, and data were collected and analysed in 2017. A publication on the work is forthcoming.

We also took part in a similar project DECODIV, through our ongoing collaboration with UCC and Prof. Paul Giller. The DECODIV project aims to investigate leaf litter decay in headwater streams across the globe using a standardised methodology. The project is being led by Luz Boyero, University of the Basque Country. Fieldwork commenced late in 2017, and data are currently being collated and analysed.

Of particular note is the inclusion of data from Lough Feeagh (Mill Race surface water temperatures) in an annual publication "The State of the Climate in (year)" which is produced every year by the *Bulletin of the American Meteorological Society.* We started contributing data to this publication in 2016, (for the 2015 period), and have now contributed to the State of the Climate report for 2015, 2016 and 2017.

10.8 BEYOND2020

BEYOND 2020 (Burrishoole Ecosystem Observatory Network 2020) is funded under the Marine Research Programme by the Irish Government. It is a multi-institute research cluster that is working with the Marine Institute Newport Catchment Facilities to build on the existing biological and sensor monitoring programme in the Burrishoole catchment in County Mayo by using next generation science and technology to inform ecosystem response to environmental change. The team, from six Irish and UK institutes, aim to maximise and enhance the current capabilities by undertaking new analysis on lake physics and aquatic ecosystem metabolism, modelling environmental variables in the recent past and into the near future, developing Burrishoole as a testbed for new chemical and biological sensors, undertaking new aerial observations using drone technology to inform on marine-freshwater links, and harnessing next generation 'omic science, to understand, predict and communicate the role and response of aquatic ecosystems in a changing global environment. In addition, the cluster will train a set of five postgraduate and four post-doctoral researchers in cutting-edge technologies, thus building capacity and ensuring the place of the Burrishoole Ecosystem Observatory Network at the forefront of national, regional and global network science in the coming decades. The project commenced in 2017 and work is ongoing. More information can be found here: https://www.dkit.ie/beyond-2020. The PIs on the project are Eleanor Jennings (DkIT) and Phil McGinnity (UCC).

10.9 Unlocking the Archive

This project is a collaboration with the Marine Institute, funded under the Marine Research Programme by the Irish Government. An aim of the project is to consolidate national collections of scales, otoliths, associated images and data into a single biochronology repository, thus maximising the use of the archive by researchers. Time series of scale/otolith growth and chemical composition will be analysed within the project to investigate how migratory fish respond to environmental change. The PI on the project is Deirdre Brophy, GMIT.

10.10 Alternative life histories (ALH): linking genes to phenotypes to demography

The Institute are collaborating with University College Cork (Dr Tom Reed), who were awarded funding for five years (2014-2019) by the European Research Council (ERC) to achieve an understanding of how genetic, environmental and physiological factors interactively shape ALH tactics in Brown Trout and how this in turn affects population demography. Project partners are the Marine Institute, Inland Fisheries Ireland and University College Cork (project lead).

Understanding how and why individuals develop strikingly different life histories is a major goal in evolutionary biology. It is also a prerequisite for conserving important biodiversity within species and predicting the impacts of environmental change on populations. The aim of the study is to examine a key threshold phenotypic trait (alternative migratory tactics) in a series of large scale laboratory and field experiments, integrating several previously independent perspectives from evolutionary ecology, ecophysiology and genomics, to produce a downstream predictive model. The chosen study species, the brown trout S*almo trutta*, has an extensive history of genetic and experimental work and exhibits 'partial migration': individuals either migrate to sea ('sea trout') or remain in freshwater their whole lives. Recent advances in molecular parentage assignment, quantitative genetics and genomics (next generation sequencing and bioinformatics) will allow unprecedented insight into how alternative life history phenotypes are moulded by the interaction between genes and environment. To provide additional mechanistic understanding of these processes, the balance between metabolic requirements during growth and available extrinsic resources will be investigated as the major physiological driver of migratory behaviour. Together these results will be used to develop a predictive model to explore the consequences of rapid environmental change, accounting for the effects of genetics and environment on phenotype and on population demographics. In addition to their value for conservation and management of an iconic and key species in European freshwaters and coastal seas, these results will generate novel insight into the evolution of migratory behaviour generally, providing a text book example of how alternative life histories are shaped and maintained in wild populations.

10.11 SFI-DEL Investigators Programme

SFI-DEL Investigators Programme 2015 15/IA/3028 (2016-2021)

Wild farmed interactions in a changing world: formulation of a predictive methodology to inform environmental best practice to secure long-term sustainability of global wild and farm fish populations.

This is a multidisciplinary study partnering the Marine Institute with University College Cork (joint project lead), Queen's University Belfast (joint project lead) and University of Glasgow funded by Science Foundation Ireland and the Department of Education and Learning for Northern Ireland which has commenced in 2016 to exploit novel analytical advances in population genomics (e.g. NGS; high density SNP arrays; gene expression; epigenetics) and quantitative genetics (e.g. animal model) to understand the complex effects of wild-farm hybridisation on the dynamics of quantitative traits and fitness in wild populations. The study aims to produce a working eco-genetic model for predicting the adaptive capacity of hybridised populations to respond to environmental change. The model can be directly applied to inform the sustainable management and/or restoration of wild populations in addition to the improvement of aquaculture strains. In addition we propose to test here several novel ideas: e.g. (1) the use of archives and pedigrees in common-garden and longitudinal studies to examine gene x environment interactions; (2) SNPs as biomarkers, which are linked to metabolism; (3) the first occurrence of the establishment of a Norwegian farm escape population in the wild outside Norway, which will enable the study of divergent selection in the farm fish in the wild relative to their farm progenitors; (4) surveys of gut and skin microbiomes and the application of assays for comprehensive screening of micro-parasites in Atlantic salmon.

10.12 BBSRC-SFI Responsive Mode

BBSRC-SFI Responsive Mode proposal Jes-1674874 (2016-2020)
A microbial basis for Atlantic salmon energetics

This multidisciplinary project which commenced in 2016 brings together world class UK and Irish fish biologists, population geneticists, microbiologists, bio-informaticians, engineers and major industry partners (Marine Institute, University College Cork – joint project lead, Marine Harvest and the University of Glasgow – joint project lead) to determine for the first time the role of salmon gut microbiota in defining host energetics, so paving the way for more sustainable salmon farming. Atlantic salmon (*Salmo salar*) are anadromous salmonids of major commercial, cultural and recreational importance in the UK, Ireland and worldwide. Metabolism, feed conversion efficiency and growth lie at the core of salmonid aquaculture productivity and its ecological impact and sustainability. The role of gut microbiota in driving energy metabolism in vertebrates is increasingly clear, opening up new avenues to fine-tune salmon metabolism and growth.

11 Publications

11.1 Peer-review

Bornarel, V., Lambert, P., Briand, C., Antunes, C., Belpaire, C., Ciccotti, E., Diaz, E., Diserud, O., Doherty, D., Domingos, I., Evans, D., de Graaf, M., O'Leary, C., Pedersen, M., Poole, R., Walker, A., Wickstrom, H., Beaulaton, L., and Drouineau, H. (2017). Modelling the recruitment of European eel (Anguilla anguilla) throughout its European range. *ICES Journal of Marine Science*, doi:10.1093/icesjms/fsx180.

Glover, K., Solberg, M.F., McGinnity, P., Hindar, K., Verspoor, E., Coulson, M.W., Hansen, M.M., Araki, H., Skaala, Ø., Svåsand, T. (2017). Half a century of genetic interaction between farmed and wild Atlantic salmon: Status of knowledge and unanswered questions, *Fish and Fisheries*.18:890–927, doi:10.1111/faf.12214

Jennings, E., de Eyto, E., Laas, A., Pierson, D., Mircheva, G., Naumoski, A., Clarke, A., Healy, M., Šumberová, K.and Langenhaun, D. (2017). The NETLAKE Metadatabase—A Tool to Support Automatic Monitoring on Lakes in Europe and Beyond. *Limnology and Oceanography Bulletin* 26 (4), 95-100.

Kelly, S., de Eyto, E., Dillane, M., Poole, R., Brett, G. and White, M. (2017). Hydrographic maintenance of deep anoxia in a tidally influenced saline lagoon. *Marine and Freshwater Research*, doi:10.1071/MF17199.

Sandlund, O.T. Diserud, O.H., Poole, R., Bergesen, K., Dillane, M., Rogan G., Durif, C., Thorstad, E.B., and Vøllestad, L.A. (2017). Timing and pattern of annual silver eel migration in two European watersheds are determined by similar cues. *Ecology and Evolution 2017*;1–1. doi: 10.1002/ece3.3099.

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White, J., O'Maoiléidigh, N., Gargan, P., de Eyto, E., Chaput, G., Roche, W., McGinnity, P., Crozier, W.W., Boylan, P., Doherty, D., others, 2017. Incorporating natural variability in biological reference points and population dynamics into management of Atlantic salmon (Salmo salar L.) stocks returning to home waters. ICES Journal of Marine Science 74, 888–888.

Woolway, I.R., Carrea, L., Marchant, C. J., Dokulil, M.T., de Eyto, E., DeGasperi, C., Korhonen, J., Marszelewski, W., May L., Paterson, A. M., Rimmer, A., Rusak, J.A., Schladow, G.S., Schmid, M., Shimaraeva, S.V., Silow, E., Timofeev, M. A., Verburg, P., Watanabe, S., Weyhenmeyer, G.A. (2017). Lake surface temperature [in "State of the Climate in 2016"]. *Bulletin of the American Meteorological Society* 98(8):S13-S14, August 2017.

Woolway, I.R., Verburg, P., Merchant, C.J., Lenters, J.D., Hamilton, D.P., Brookes, J., Kelly S., Hook, S., Laas, A., Pierson, D., Rimmer, A., Rusak, J.A., and Jones, I.D. (2017). Latitude and lake size are important predictors of over-lake atmospheric stability. *Geophys. Res. Lett., 44*, 8875–8883, doi:10.1002/2017GL073941.

11.2 Reports - 2017

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ICES. 2017. Final Report of the Working Group on the Science Requirements to Support Conservation, Restoration and Management of Diadromous Species (WGRECORDS), 19th September 2017, Fort Lauderdale, USA. ICES CM 2017/SSGEPD:17. 47pp.

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ICES. 2017. Report of the Working Group on Eels (WGEEL), 3-10 October 2017, Kavala, Greece. ICES CM 2017/ACOM:15. 101pp.

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ICES. 2017. Report of the Working Group with the Aim to Develop Assessment Models and Establish Biological Reference Points for Sea Trout (Anadromous Salmo trutta) Populations (WGTRUTTA), 24-26 April 2017, Gothenburg, Sweden. ICES CM 2017/SSGEPD: 21. 10pp.

SSCE. 2017. Activity report of the Standing Scientific Committee on Eel, 2016. Report to DCENR & IFI; 176pp.