

Fish Stock Survey - Monitoring Report



Action E3

LIFE09 NAT/IE/000220 BLACKWATER SAMOK

2014

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Executive Summary

This report summarises the results of three years of electrofishing surveys in the Allow catchment (2011, 2012, 2014). All four sites were sampled using the electrofishing method by staff of IRD Duhallow and Inland Fisheries Ireland. Salmon and trout were the two dominant species and only these two species were used for comparative analysis.

The main aim of the fish monitoring was to try and detect whether erosion remediation works had had a positive or negative impact of fish density at an experimental site (Curragh). The monitoring results were compared to 3 control sites on the Brogeen and Dalua rivers. In 2012, a total of 697 salmonids were recorded throughout the entire survey over the four sites. In 2014, four sites were surveyed with a total of 710 salmonids documented. The mean 2014 density for salmon in the four comparison sites was 0.598m^2 . While this is an increase from the previous study in 2012 (0.404m^2), a paired t-test found that it was not a statistically significant. While there was a fall in average trout density, the decrease from 0.035 trout per m^2 to 0.028 per m^2 , this was not statistically significant.

The lack of fish monitoring data to show improvements in salmonid populations at the Curragh site post rehabilitation work is unsurprising, given the short time period of the LIFE project. Other factors also influence fish density such as river water levels, pollution incidents, and poor spawning seasons. A more robust and longer term monitoring programme is required to better assess the impacts, either positive or negative, that the bank rehabilitation works had on the population of salmon and trout in the lower Dalua.

Background

This report summarises the results of three years of electrofishing surveys in the Allow catchment. Electrofishing involves creating an electric field in the water that temporarily immobilises the fish or influences the direction in which they swim, making them relatively easy to capture with a net. In the context of this project, electrofishing was utilised as a method to determine whether fish densities (Brown trout and Atlantic salmon) had improved at sites which had undergone river rehabilitation work to improve fish habitat.

An electrofishing survey was conducted in September 2011. The monitoring programme was designed to assess the status of salmon and trout in the Allow and Dalua rivers. This served as a baseline for further monitoring of salmonid stocks in the catchment. In 2012, the River Brogeen was added to the monitoring programme, and DuhallowLIFE in partnership with Inland Fisheries Ireland (IFI), conducted a second season of electrofishing. Unfortunately, problems with getting licenses for river rehabilitation work, and a reduction in the availability of field staff in 2014, meant that the monitoring effort had to be reduced from thirteen sites to four.

The 2014 monitoring concentrated efforts at one experimental site (Curragh) and three control sites (2 at Paal West, 1 at Garraunawarrig Lower). The experimental site was suffering from excessive bank erosion brought about by a lack of riparian vegetation, and poaching by livestock and poor land management. For this reason, the site underwent erosion remediation works including riverbank re-profiling, tree planting, and riparian fencing to exclude livestock. As salmon spawning grounds depend on clean, well oxygenated gravels (O'Grady, 1993), the above works aimed to reduce the quantity of fine sediment infiltrating the river's gravel beds (Igoe & Murphy, 2014). The control sites were sampled to provide a comparison with the experimental site.

Site Description

The River Allow catchment is 310km² (Figure 1). The three major rivers that drain the catchment are the Allow, Dalua and Brogeen. The main land use in the catchment is agricultural, with pasture based dairying and beef production of most importance.

The majority (70%) of soil in the Allow catchment is deep, poorly drained mineral soil. Blanket peat covers approximately 5% of the catchment, mostly in upland reaches. Mineral alluvium is

associated with the river channels, while shallow well drained mineral soils make up the remaining soil type in the catchment (Tedd, 2014).

The Allow catchment rivers (Allow, Dalua, Brogeen, Glenlara and Owenkeale) form part of the Blackwater River (Cork/Waterford) Special Area of Conservation (Natura 2000 site code: 002170). These tributaries provide important habitat for FPM, Atlantic salmon (*Salmo salar*) and European otter (*Lutra lutra*), all of which are listed in the Annex II of EU Habitats Directive. The upper reaches of the Allow catchment contain the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle Special Protection Area, which was designated as such for Hen Harrier (*Circus cyaneus*) (listed in Annex I of the EU Bird's Directive).

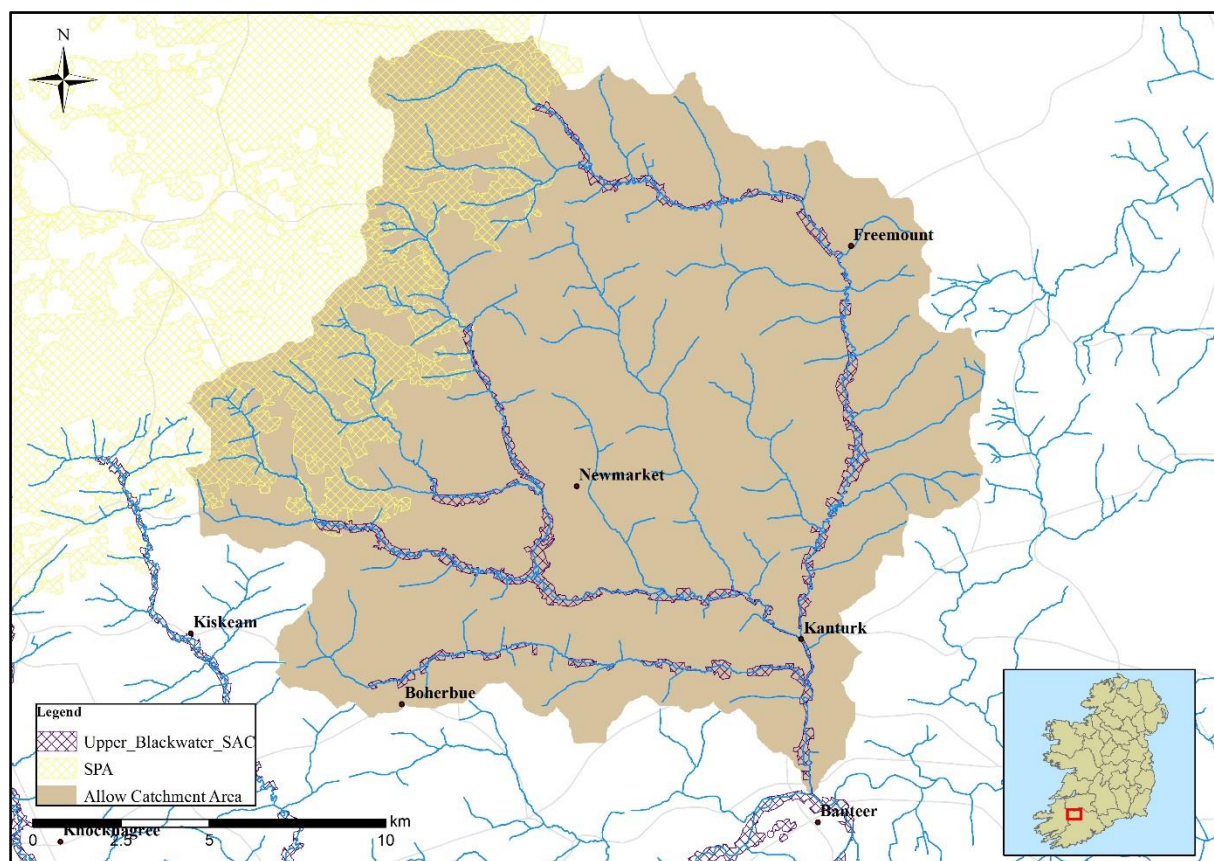


Figure 1 River Allow catchment area targeted by the DuhallowLIFE Project (LIFE09 NAT/IE/000220 Blackwater SAMOK)

Methodology

Electrofishing surveys

Two electrofishing techniques were employed to sample all sites for fish. These were bank based depletion electrofishing (wadeable rivers) and boat based depletion electrofishing (non – wadeable rivers). These surveys were conducted by trained operators employed by Inland Fisheries Ireland who were assisted by the Duhallow LIFE project team and participants from the Rural Social Scheme (RSS). Dr Cathal Gallagher organised the required survey licensing for the assessment. DuhallowLIFE negotiated permissions with landowners.

Bank based depletion electrofishing

In wadeable waters (generally spawning and nursery waters) fish monitoring was carried out using bank based electrofishing equipment. This consisted of one or more portable generators (220/240 v) with appropriate control units (DC converter) attached, along with a cathode (metal plate) and an anode (hand net) for each unit (plate 1). Generally speaking, most sites sampled this way were 30 to 40 metres long (Figure 2).



Figure 2 Electrofishing from the bank in wadeable streams

Boat based depletion electrofishing

In deeper waters (non-wadeable) electrofishing was carried out by boat. This involved the use of a heavy duty 220v generator with an appropriate control unit along with both an anode and

cathode, which were mounted in a flat bottomed boat crewed by three staff per boat. Up to two boats were employed on the larger channels fished (Figure 3).



Figure 3 Electrofishing in non-wadeable rivers using boats

Data analysis

Microsoft Excel was used for statistical analysis and graphical presentation. Salmonid densities were calculated for all sites.

Paired sample t-tests were conducted to compare the frequencies of salmon caught in 2012 and 2014, and compare the densities of salmon in each year.

Paired sample t-tests were conducted to compare the frequencies of trout caught in 2012 and 2014, and compare the densities of trout in each year.

Paired sample t-tests were conducted to compare the total number of salmon and trout calculated for 2012 and 2014 at the experimental site.

Results and discussion

Electrofishing surveys

The following section presents the fish monitoring data in tables and bar graphs. This is followed by statistical analysis and discussion of the monitoring results.

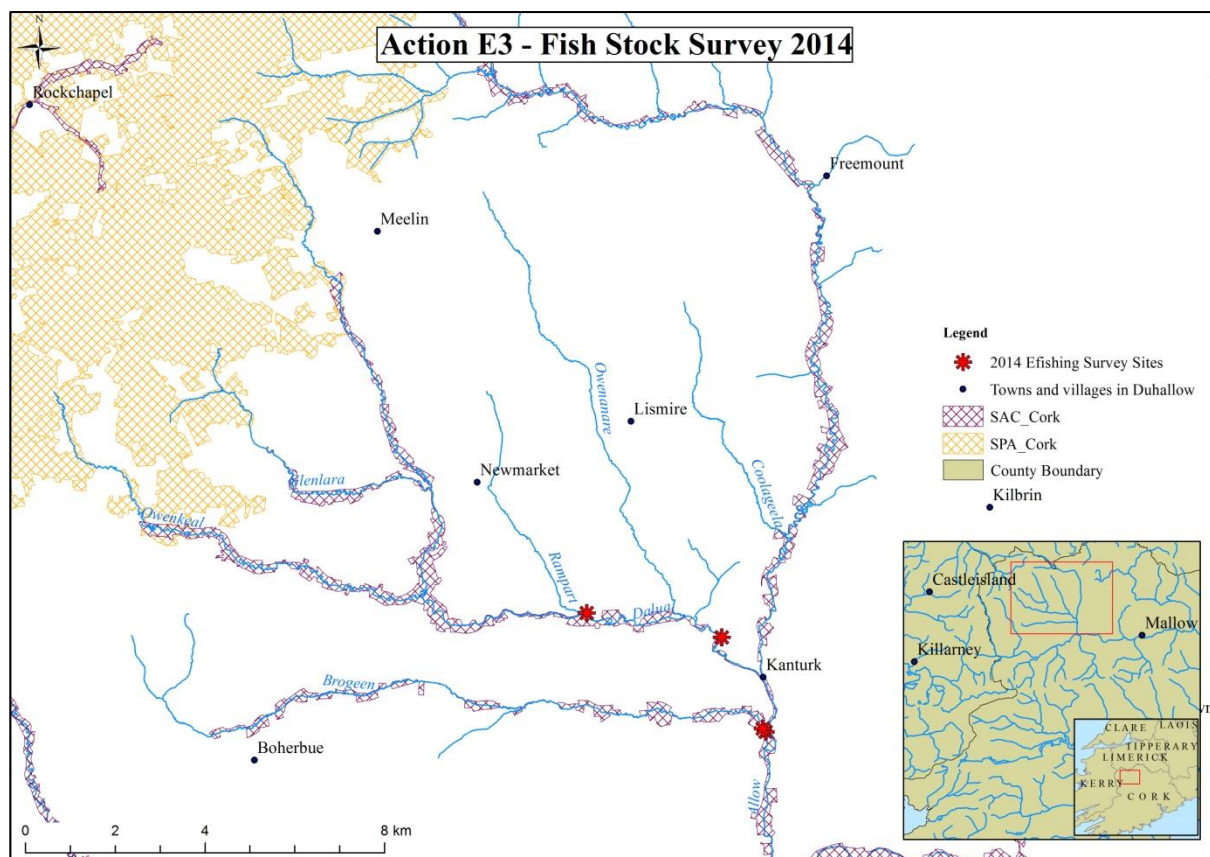


Figure 4 List of electrofishing survey sites in the Allow Catchment.

Table 1 List of electrofishing survey sites and the site type

Site	Grid Reference	River	Townland	Site Type
1 - Kanturk castle (a)	138290, 101928	Brogeen	Paal West	Control
2 - Kanturk castle (b)	138209, 102015	Brogeen	Paal West	Control
3 - Curragh	137299, 104091	Dalua	Curragh	Experimental
4 - Allens Bridge	134363, 104466	Dalua	Garraunawarrig Lower	Control

Site 1 – Brogeen river at Kanturk castle (a)

Date: 29.09.2014

Location: Brogeen River; Grid reference 138209, 101928

Operators: Karen Delanty, Ronan Cooney, Michael O'Mahony, Mick Faul, Mick Fanning, Andrew Gillespie, Colm O'Connell.

Details:

- 36.5m length x 9.1/7.1/4.6m width (253m²)
- Velocity status: low; Velocity rating: slow.
- Pasture on LHB, woodland (Alder, Willow and Sycamore) on RHB, shading <25%.
- In-stream Callitriche and Ranunculus.
- Shallow rifle and glide.
- Good spawning potential, but fish numbers are low.
- Poor nursery waters as there is no depth.
- Water level low, due to no rain for a month.
- Substrate mostly cobble and gravel, layer of silt present.

Table 2 Number of trout and salmon caught during electrofishing survey on the Brogeen – Site 1 (29.09.14)

Fish development	Trout				Salmon			
	1 st	2 nd	3 rd	Total	1 st	2 nd	3 rd	Total
Fry	3	1	0	4	49	14	0	63
Par	0	0	0	0	5	0	0	5

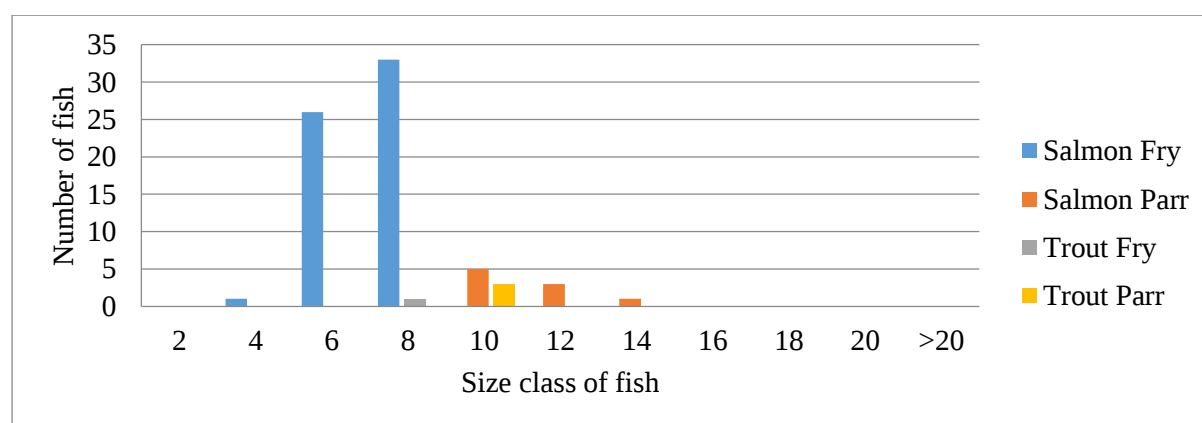


Figure 5 Size classes of salmon and trout caught in electrofishing survey at Site 1- Brogeen on the 29.09.2014.

Table 3 Other fish species caught during electrofishing survey at Site 1- Brogeen on the 29.09.2014.

Fish species	Total number recorded
Stone loach (<i>Barbatula barbatula</i>)	3
Lamprey (Transformers) (<i>Lamprera</i> sp)	3
Eel (<i>Anguilla Anguilla</i>)	2
Stickleback (<i>Gasterosteus aculeatus</i>)	9

Site 2 – Brogeen river at Kanturk castle (b)

Date: 29.09.2014

Location: Brogeen River; Grid reference 138209 102015

Operators: Karen Delanty, Ronan Cooney, Michael O'Mahony, Mick Faul, Mick Fanning, Andrew Gillespie, Colm O'Connell.

Details:

- 43.5m length x 2.5/3.5/4m width (435m²).
- Velocity status: low; Velocity rating: slow.
- Pasture on LHB, woodland (Alder, Willow and Sycamore) on RHB, shading <50% (in places at top of site it would be <75%).
- In-stream mosses.
- Shallow rifle and glide.
- Good potential for salmon, but numbers are low.
- Slight bank erosion.

Table 4 Number of trout and salmon caught during electrofishing survey at Site 2 - Brogeen 29.09.2014

Fish development	Trout				Salmon			
	1 st	2 nd	3 rd	Total	1 st	2 nd	3 rd	Total
Fry	1	1	0	2	44	25	0	69
Par	2	1	0	3	15	3	0	18

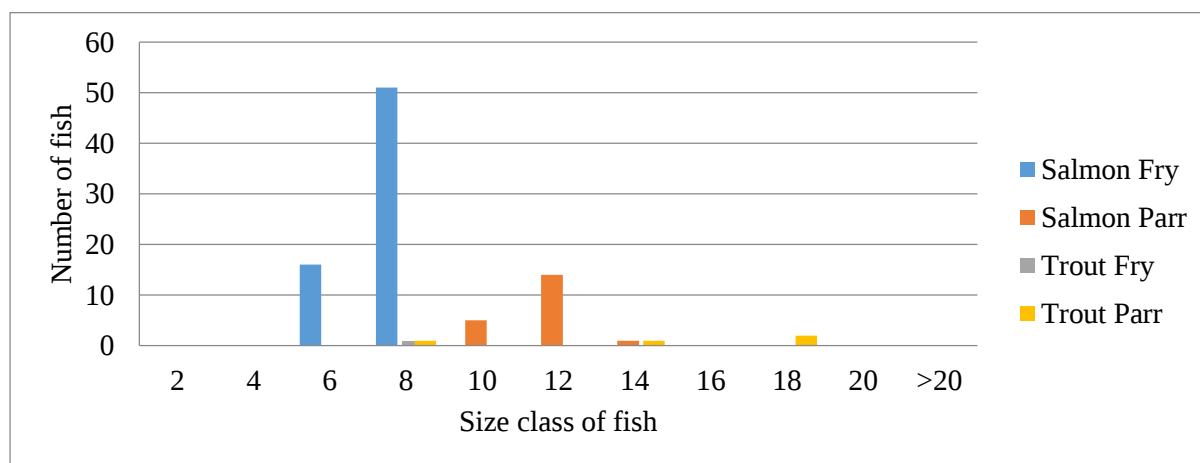


Figure 6 Size classes of salmon and trout caught in electrofishing survey at Site 2 – Brogeen 29.09.2014

Table 5 Other fish species caught during electrofishing survey Site 2 – Brogeen 29.09.2014

Fish species	Total number recorded
Stone loach (<i>Barbatula barbatula</i>)	11
Lamprey (Transformers) (<i>Lampreta</i> sp)	2
Eel (<i>Anguilla Anguilla</i>)	2
Stickleback (<i>Gasterosteus aculeatus</i>)	5

Site 3 - Dalua river at Curragh

Date: 30.09.14

Location: River Dalua; Grid reference 137299 104091

Operators: Karen Delanty, Ronan Cooney, Michael O'Mahony, Mick Faul, Colm O'Connell

Details:

- 20m length x (7.6/3.9/4.3m) width (316m²).
- Velocity status: low/medium; Velocity rating: slow/medium.
- Willows planted on top of bank and armouring for bank protection 2 years ago.
- Water level low, no rain for a month.
- Should be a good nursery in deeper sections.
- Pasture on both banks and fenced.
- Some algae.
- Fished rifle area only.
- No over shading.

Table 6 Number of trout and salmon caught during electrofishing survey at Site 3 – Dalua 30.09.2014

Fish development	Trout				Salmon			
	1 st	2 nd	3 rd	Total	1 st	2 nd	3 rd	Total
Fry	1	1	0	2	71	37	25	133
Par	12	5	2	19	11	16	16	43



Figure 7 Size classes of salmon and trout caught in electrofishing survey at Site 3 – Dalua 30.09.2014

Table 7 Other fish species caught during electrofishing survey on the at Site 3 – Dalua 30.09.2014

Fish species	Total number recorded
Stone loach (<i>Barbatula barbatula</i>)	8
Lamprey (Transformers) (<i>Lampreta</i> sp)	3
Eel (<i>Anguilla Anguilla</i>)	2
Stickleback (<i>Gasterosteus aculeatus</i>)	1

Site 4 – Dalua river at Allens Bridge

Date: 30.09.2014

Location: River Dalua, Grid reference 134363 104466

Operators: Karen Delanty, Ronan Cooney, Michael O'Mahony, Mick Faul, Colm O'Connell

Details:

- 34.3m length x (7.7/10/9.9m) width (323.56m²).
- D/s of Allensbridge, along old railway line.
- Recent tree pruning here and Himalayan balsam removal.
- Substrate nearly all cobble and gravel.
- In-stream vegetation algae and mosses.
- Fenced pasture on both banks.
- Slight bank erosion and overhanging. Light shading <25% with Alder and Willow.
- 80% rifle 20% glide.
- Velocity status slightly med/low. Velocity rating moderate/low.
- Excellent Salmon spawning, no great depth for larger fish, but low water levels due to no rain in a month

Table 8 Number of trout and salmon caught during electrofishing survey at Site 4 - Dalua 30.09.2014

Fish development	Trout				Salmon			
	1 st	2 nd	3 rd	Total	1 st	2 nd	3 rd	Total
Fry	5	1	1	7	122	103	73	298
Par	1	2	0	3	24	6	12	42



Figure 8 Size classes of salmon and trout caught in electrofishing survey at Site 4 - Dalua 30.09.2014

Table 9 Other species recorded during electrofishing survey on the Allow – Site 4 (11.09.12)

Fish species	Total number recorded
Stone loach (<i>Barbatula barbatula</i>)	63
Lamprey (Transformers) (<i>Lampreta</i> sp)	2
Minnow (<i>Phoxinus phoxinus</i>)	1

Statistical analysis

Due to planning and licencing problems, much of the bank restoration work planned for the Allow did not go ahead as originally intended. For this reason, the 2014 survey concentrated on the Curragh site on the Dalua river, where extensive rehabilitation work had taken place. Curragh served as an experimental site, with the other three sites acting as controls. Originally, more sites were to have instream rehabilitation work, hence the larger number of sites surveyed in 2011 and 2012. While bank modification work was not undertaken, other habitat improvement activities such as invasive plant control, willow spilling, tree planting, and riparian fencing, did proceed. However, these activities will take much longer than the bank rehabilitation work in Curragh to show any appreciable improvement in salmon and trout stocking densities. Only the site in Curragh was surveyed over three years (2011, 2012, 2014). Therefore, this was the only site where comparative data was used to conduct statistical analysis on the minimum stocking densities recorded.

Table 10 Surveys conducted in 2012 and 2014 including the densities (fish per m²) recorded from each sites

Site	Location	River	Salmon				Trout			
			2012	Density	2014	Density	2012	Density	2014	Density
1	Kanturk Castle (a)	Brogeen	69	0.321	68	0.268	4	0.018	4	0.0158
2	Kanturk Castle (b)	Brogeen	71	0.163	87	0.600	19	0.043	5	0.0344
3	Curragh	Dalua	287	0.437	176	0.556	10	0.015	21	0.0664
4	Allens Bridge	Dalua	225	0.695	340	0.968	12	0.037	9	0.0256
Mean			163	0.404	168	0.598	11.25	0.028	9.75	0.0356
Total			652	-	671	-	45	-	39	-

In 2012, a total of 697 salmonids were recorded throughout the entire survey over the four sites. In 2014, four sites were surveyed with a total of 710 salmonids documented. The mean 2014 density for salmon in the four comparison sites was 0.598m² (Table 10). While this is an increase from the previous study in 2012 (0.404m²), a paired t-test found that it was not a statistically significant increase in density ($p = 0.160$). While there was a fall in average trout density, the decrease from 0.035 trout per m² to 0.028 per m², was not statistically significant ($p = 0.672$, paired t-test) (Table 11).

Table 11 T-test comparing salamonid density between 2012 and 2014.

Fish density t-tests	
<i>Salmon</i>	<i>Trout</i>
0.160	0.672

When the salmonids were categorised into fry and parr, there were no noted differences recorded. Paired t-tests were conducted to compare the densities in fry and parr of both salmonids between 2012 and 2014 (Table 12). No statistically significant differences were found ($p > 0.05$, paired t-test).

Table 12 T-test comparing salmonid densities (fry and parr groups) between 2012 and 2014

T-test	Salmon fry	Salmon parr	Trout fry	Trout parr
Frequency	0.421	0.285	0.250	0.461
Density	0.065	0.478	0.450	0.344

Crozier and Kennedy (1994) rank the density of <0.3 salmon fry per m^2 , and 0.05 salmon parr per m^2 as poor, and densities of salmon fry >0.9 and >0.2 salmon parr as excellent (Table 13). In 2012, the mean densities of salmon fry and parr in the four comparison sites was $0.315m^2$ and $0.084m^2$ respectively. In 2014, salmon fry and parr densities increased to $0.345m^2$ and $0.068m^2$, respectively. Using Crozier and Kennedy's (1994) classifications system, the average density recorded for both salmon fry and parr, remained fair.

Table 13 Classification system for salmon densities (Crozier and Kennedy, 1994).

Fry Density	Parr Density	Classification
> 0.9	> 0.2	Excellent
0.6 - 0.89	0.1 - 0.199	Good
0.3 - 0.59	0.05 - 0.099	Fair
0.001 - 0.29	0.001 - 0.049	Poor
0	0	Absent

The only marked (statistically significant) difference recorded at the Curragh site over the three surveys (2011, 2012 and 2014) was with trout parr ($p = 0.016$) (Table 15). After conducting single factor ANOVA tests on all four categories (salmon fry, salmon parr, trout fry and trout parr) over the three survey dates at the Curragh site it was found that the only statistically significant difference was with trout parr ($p = 0.037$). The Tukey-Kramer (Honest Significant Difference) post hoc procedure was then used to establish that the decrease in trout parr densities between 2011 (pre-works) and 2012 (post-works) was statistically significant. Densities increased again in 2014, and the comparison between that year and 2011 was not significantly different (See appendix for results of statistical tests).

Table 12 Trout fry and parr densities recorded at Site 3 in 2012 (656m²) and 2014 (316m²). Paired t-tests were also conducted to compare densities in the two years.

Minimum Trout Fry Densities			Minimum Trout Parr Densities		
Length (cm)	2012	2014	Length (cm)	2012	2014
2	0	0	<12	0.002	0
4	0	0	<14	0	0.006
6	0.003	0	<16	0.003	0.019
8	0.002	0	<18	0	0.006
10	0.002	0.010	<20	0.002	0.009
			>20	0.003	0.022
Average	0.001	0.003	Average	0.002	0.010
Trout Fry Densities t-test			Trout Parr Densities t-test		
0.487			0.016		

Although the three control sites were used in 2014 and 2012, not enough data was collected to monitor trends as they were not surveyed in 2011. Any difference found between years cannot be used to qualify whether rehabilitation works have improved or diminished fish stock densities at the Curragh site. Other factors also influence fish density such as river water levels, pollution incidents, and poor spawning seasons. A more robust and longer term monitoring programme is required to better assess the impacts, either positive or negative, that the bank rehabilitation works had on the population of salmon and trout in the lower Dalua.

Conclusion

Electricfishing surveys in the Brogeen and Dalua rivers were undertaken in 2011, 2012, and 2014. Site 3 at Curragh underwent river bank stabilisation work. The monitoring results of pre and post stabilisation work at Curragh was compared with 3 control sites to try and detect whether the river rehabilitation actions had improved the fish population at this site. The only statistically significant change in fish density was a slight decline in trout parr.

The lack of fish monitoring data to show improvements in salmonid populations at the Curragh site post rehabilitation work is unsurprising, given the short time period of the LIFE project. A long term monitoring programme is required to properly assess whether the river rehabilitation work has had an effect on localised fish populations.

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Appendix

Electric fishing monitoring data in summary tables.

Table 13 Salmon fry densities at the Curragh Site (Dalua) over the three salmonid stock monitoring surveys

Minimum Salmon Fry Densities (no./m ²)			
Length (cm)	2011	2012	2014
<2	0	0	0
<4	0	0	0
<6	0.009146	0.216463	0.148734
<8	0.019817	0.158537	0.126582
<10	0.012195	0.022866	0.14557
Mean	0.008232	0.079573	0.084177

Table 14 Salmon parr densities at the Curragh Site (Dalua) over the three salmonid stock monitoring surveys

Minimum Salmon Parr Densities (no./m ²)			
Length	2011	2012	2014
<12	0.007622	0.019817	0.053797
<14	0.02439	0.01372	0.075949
<16	0.001524	0.004573	0.009494
<18	0	0	0
<20	0	0	0
>20	0.003049	0	0
Mean	0.006098	0.006352	0.023207

Table 15 Trout fry densities at the Curragh Site (Dalua) over the three salmonid stock monitoring surveys

Minimum Trout Fry Densities (no./m ²)			
Length	2011	2012	2014
<2	0	0	0
<4	0	0	0
<6	0	0.003049	0
<8	0.006098	0.001524	0
<10	0	0.003049	0.006329
Mean	0.00122	0.001524	0.001266

Table 16 Trout parr densities at the Curragh Site (Dalua, 656m²) over the three salmonid stock monitoring surveys

Minimum Trout Parr Densities (no./m ²)			
Length	2011	2012	2014
<12	0	0.001524	0
<14	0.010671	0	0.006329
<16	0.006098	0.003049	0.018987
<18	0.036585	0	0.006329
<20	0.028963	0.001524	0.009494
>20	0.051829	0.003049	0.022152
Mean	0.022358	0.001524	0.010549

Table 17 Number of salmon recorded in the Allow catchment (fry and parr) in 2012 and 2014. Densities are in salmon per m².

Site	Location	River	Salmon Fry				Salmon Parr			
			2012	Density	2014	Density	2012	Density	2014	Density
1	Kanturk Castle	Brogeen	44	0.204937	63	0.249012	25	0.116442	5	0.019762846
2	Kanturk Castle (b)	Brogeen	58	0.133333	69	0.475862	13	0.029885	18	0.124137931
3	Curragh	Dalua	261	0.397866	133	0.420886	25	0.03811	43	0.136075949
4	Allens Bridge	Dalua	151	0.466683	298	0.849003	74	0.228706	42	0.11965812
		Total	514		563		137		108	
		Mean	128.5	0.315481	140.75	0.345556	34.25	0.084087	27	0.066287763

Table 18 Number of trout recorded in the Allow catchment (fry and parr) in 2012 and 2014. Densities are in trout per m²

Site	Location	River	Trout Fry				Trout Parr			
			2012	Density	2014	Density	2012	Density	2014	Density
1	Kanturk Castle	Brogeen	0	0	4	0.01581	4	0.018631	0	0
2	Kanturk Castle (b)	Brogeen	9	0.02069	2	0.013793	10	0.022989	3	0.020689655
3	Curragh	Dalua	5	0.007622	2	0.006329	5	0.007622	19	0.060126582
4	Allens Bridge	Dalua	8	0.024725	7	0.019943	4	0.012362	3	0.008547009
		Total	22		15		23		25	
		Mean	5.5	0.013503	3.75	0.009207	5.75	0.014117	6.25	0.015344389

Statistical tests

Table 19 Salmon fry and parr densities recorded at Site 3 (Curragh) in 2012 (656m²) and 2014 (316m²). Paired t-tests were also conducted to compare densities in the two years

Minimum Salmon Fry Densities			Minimum Salmon Parr Densities		
Length (cm)	2012	2014	Length (cm)	2012	2014
<2	0	0	<12	0.020	0.054
<4	0	0	<14	0.014	0.076
<6	0.216	0.149	<16	0.005	0.009
<8	0.159	0.127	<18	0	0
<10	0.023	0.146	<20	0	0
			>20	0	0
Average	0.080	0.084	Average	0.006	0.023
Salmon Fry Densities t-test 0.446			Salmon Parr Densities t-test 0.086		

Table 20 Trout fry and parr densities recorded at Site 3 in 2012 (656m²) and 2014 (316m²). Paired t-tests were also conducted to compare densities in the two years.

Minimum Trout Fry Densities			Minimum Trout Parr Densities		
Length (cm)	2012	2014	Length (cm)	2012	2014
2	0	0	<12	0.002	0
4	0	0	<14	0	0.006
6	0.003	0	<16	0.003	0.019
8	0.002	0	<18	0	0.006
10	0.002	0.010	<20	0.002	0.009
			>20	0.003	0.022
Average	0.001	0.003	Average	0.002	0.010
Trout Fry Densities t-test 0.487			Trout Parr Densities t-test 0.016		

Table 21 Single Factor ANOVA test results on Salmon Fry records from the Curragh site in the years 2011, 2012 and 2014

2014

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
2011	5	0.041159	0.008232	7.16E-05		
2012	5	0.397866	0.079573	0.010213		
2014	5	0.420886	0.084177	0.005977		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.018131	2	0.009065	1.672426	0.228724	3.885294
Within Groups	0.065046	12	0.005421			
Total	0.083177	14				

Table 22 Single Factor ANOVA test results on Salmon Parr records from the Curragh site in the years 2011, 2012 and 2014

and 2014

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
2011	6	0.036585	0.006098	8.83E-05		
2012	6	0.03811	0.006352	7.2E-05		
2014	6	0.139241	0.023207	0.001104		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.001154	2	0.000577	1.368625	0.284471	3.68232
Within Groups	0.006323	15	0.000422			
Total	0.007476	17				

Table 23 Single Factor ANOVA test results on Trout Fry records from the Curragh site in the years 2011, 2012 and 2014

2014

Anova: Single Factor							
SUMMARY							
Groups	Count	Sum	Average	Variance			
2011	5	0.006098	0.00122	7.44E-06			
2012	5	0.007622	0.001524	2.32E-06			
2014	5	0.006329	0.001266	8.01E-06			
ANOVA							
Source of Variation	SS	df	MS	F	P-value	F crit	
Between Groups	2.7E-07	2	1.35E-07	0.022783	0.977517	3.885294	
Within Groups	7.11E-05	12	5.92E-06				
Total	7.14E-05	14					

Table 24 Single Factor ANOVA test results on Trout Parr records from the Curragh site in the years 2011, 2012 and 2014

Anova: Single Factor						
SUMMARY						
Groups		Count	Sum	Average	Variance	
2011		6	0.134146	0.022358	0.000403	
2012		6	0.009146	0.001524	1.86E-06	
2014		6	0.063291	0.010549	7.08E-05	
ANOVA						
Source of Variation		SS	df	MS	F	P-value
Between Groups		0.00131	2	0.000655	4.130046	0.037248
Within Groups		0.002379	15	0.000159		
Total		0.003688	17			

Table 25 Results of the Tukey-Kramer Procedure comparing Trout Parr results in the years 2011, 2012, 2014 (Numerator degrees of freedom = 3; Demoninator degrees of freedom = 15; Q_μ = 3.609)

Tukey-Kramer Procedure			
Comparison	Absol. Diff.	Critical Range	Results
2011 to 2012	0.020833333	0.017461663	Significantly different
2011 to 2014	0.017276423	0.017461663	Not significantly different
2012 to 2014	0.003556911	0.017461663	Not significantly different