AGRI-FOOD & BIOSCIENCES INSTITUTE

DAERA Area Brown Trout Status Report & Research update

2024

Contents

1 Introduction

The statutory responsibility for the conservation, protection and management of salmon, eels and inland fish within Northern Ireland (excluding the Loughs Agency area), lies with the Department of Agriculture, Environment and Rural Affairs (DAERA). DAERA have commissioned AFBI to undertake scientific research on brown trout (*Salmo trutta* L.) stocks within the DAERA area in Northern Ireland. This report provides an update on brown trout science undertaken at AFBI and builds upon a previous report published in 2011 (Kennedy *et al*., 2011).

Brown trout are a probably the most widespread fish species in Northern Ireland, present in almost all flowing water and interconnected lakes and coastal areas. Since the end of the last glaciation they are naturally absent only from small lakes with soft sediments and lacking significant feeder streams. Brown trout exhibit extreme variablity in their life strategy, and include; sea growing, river spawning (anadromous) sea trout, lake resident, river spawning (potamodromous) trout of Loughs Neagh, Erne, Melvin and smaller lakes, and purely river resident forms. There are also some small upland lakes with trout which spawn on lake margins where there are no feeder streams. Lake trout spawning can take place in influent or effluent streams of lakes. Growth rates are as variable as the life strategy, with fish first maturing at anything from 15 cm in small upland rivers to over 50 cm in the case of some lake fish. Maximum size again depends on habitat and ranges from less than 20 cm up to 80 cm.

2 Fisheries

Historically a small commercial fishery for sea trout was conducted along the northeast coast of Co. Antrim and on the southeast coast of Co. Down. Sea trout were mostly landed as a by-catch in these seasonal salmon fisheries. Historical sea trout catches in N. Ireland (outside of Lough Foyle) peaked in 1984 with around 946 sea trout reported (Moffet & Crozier, 1999). Since 2012 no commercial fishery has been licenced for the exploitation of sea trout in N. Ireland.

A commercial fishery for potamodromous brown trout is conducted in Lough Neagh. This fishery is regulated by technical conservation measures outlined within the Lough Neagh Fishery Management Plan which include fishing exclusion zones (around river mouths), a minimum landing size (35.5 cm) with associated gear restrictions (mesh size, net length) and a close season with the trout fishing period lasting from 1st March to the 19th August. Trout fishing is mostly conducted by trammel and draft net, although trout may be taken as a bye-catch in other commercial fisheries on the Lough. The commercial fishery in Lough Neagh has recently been reviewed and the technical conservation measures applicable for trout updated through the DAERA Fishery Management Plans (https://www.daera-ni.gov.uk/publications/lough-neagh-fishery-management-plan).

2.1 Recreational Fisheries

Anglers are required by statue to release any sea trout captured in the DAERA area of N. Ireland. No recreational harvest of sea trout, of any size, has been allowed from 2012 and therefore N. Ireland technically represents a sanctuary region for these anadromous fish. Wild potamodromous trout (inclusive of river resident and lake running stocks) can be taken by rod and line anglers and current technical conservation measures to control exploitation include a

minimum landing size (25.4 cm) across all fisheries (except Lough Erne which has a limit of 30cm), variable daily bag limits (4 trout/day on most fisheries) and a closed season.

3 The Status of Brown Trout in N. Ireland

The primary long-term data collected for brown trout in N. Ireland is via summer electric fishing surveys focused on young-of-year (0+ age class) juveniles. Two survey methods are utilised including a Semi-Quantitative (SQ), catch-per-unit-effort, technique (Crozier & Kennedy, 1994) and a more intensive multiple pass depletion (Fully Quantitative- FQ) technique (Kennedy *et al*., 2014).

The SQ data are collected across multiple sites through-out a number of monitored catchments and provide a relative 'index' of abundance. The SQ data are not designed to facilitate detailed comparison of fry abundance between catchments, given the inevitable differences in catchability and habitat composition between different rivers, but do provide an excellent means to chart the overall *trend* in recruitment *within* a monitored river over time.

The FQ data are collected at long term monitoring stations on six rivers across Northern Ireland (the Main, Blackwater, Sixmile, Clady, Garvary, Shimna). These surveys provide a robust estimate of the spatial density (no. fish /100m^2) of young-of-year trout, which can be compared between sites/rivers. These data critically facilitate comparison of trout abundance (% compliance) against defined biological reference points.

3.1 Trout Recruitment Trends in Northern Ireland rivers.

SQ time-series data were tabulated for 20 rivers throughout N. Ireland. The length of time series required to calculate trend status is an important factor, with a minimum duration of at least 10 years required to reflect two full trout generations and indicate longer-term patterns (ICES, 2011). Datasets were initially checked for first order autocorrelation using the Durban-Watson test. The Pearson (r) coefficient was then calculated for each individual time series to indicate the strength and direction (positive or negative) of potential trends. Rivers were

grouped into geographical regions including north coast trout rivers (Dun, Bush, Ballycastle), South East Antrim (Glenarm, Inver, Threemilewater), Mournes (Shimna, Moneycarragh, Annalong, Kilkeel), Lough Neagh rivers (Main, Blackwater, Sixmile, Clady, Agviey) and Lough Erne tributaries (Ballinamallard, Kesh, Colebrooke and Garvary) (Fig 1).

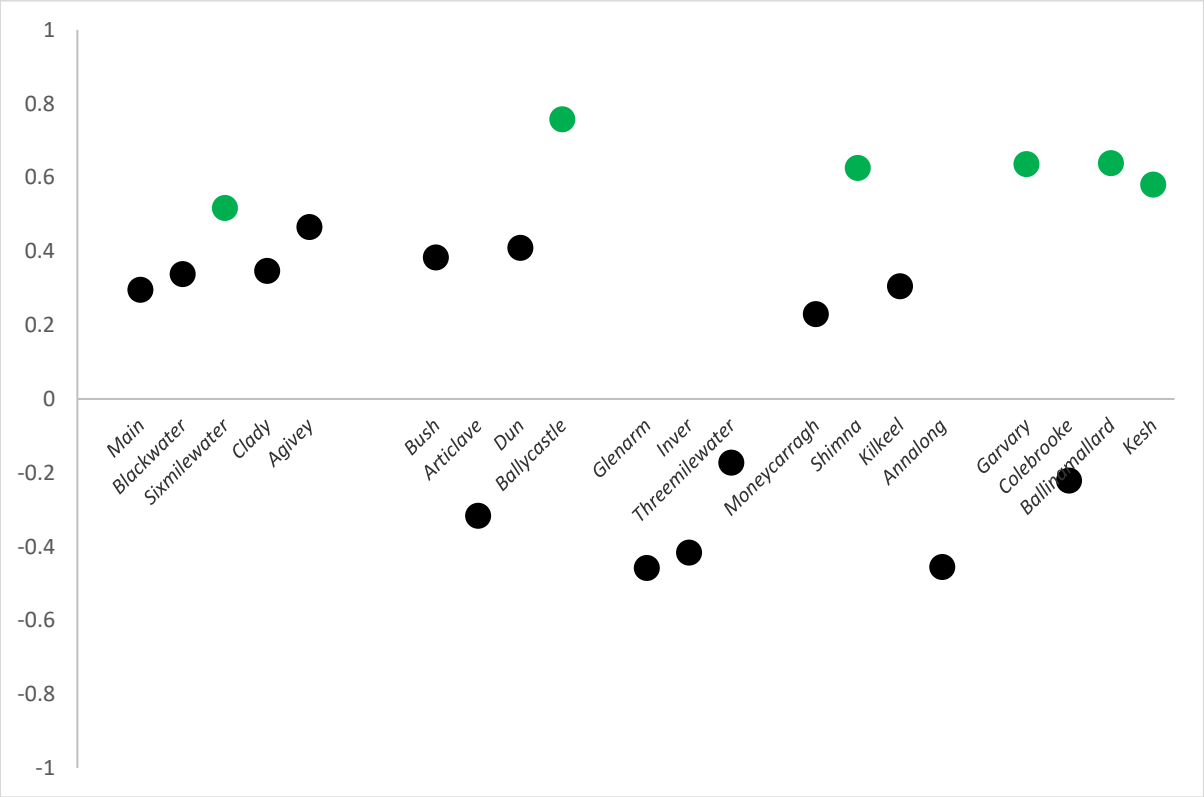


Fig 1. Pearson correlation coefficients showing trend strength (0-1) and direction (+/-) in recruitment of 0+ trout across a panel of rivers with sufficient time-series data (>10 years). Non-significant trends indicated by black circles, significant correlations are indicated by green (+) and red (-) circles.

Fig 1 outlines the overall trends in abundance across the range of monitored rivers. Most rivers (70%) showed increasing recruitment levels across the available time-series. All the monitored

rivers in the Neagh/Bann catchment exhibited increasing recruitment performance across their corresponding time-series, with the Sixmilewater showing a statistically significant increase during a 16-year period (2008-2023). The North coast rivers showed an increasing recruitment trend, except for the Articlave river in the Bann estuary which had a negative correlation coefficient (-0.33). The rivers located in the Southeast Antrim region fared worse than the other regions with all three monitored stocks (Glenarm, Inver & Threemilewater) consistently exhibiting negative trends in 0+ trout recruitment patterns. A useful further investigation could assess whether common biotic or abiotic factors are influencing recruitment over a regional scale across these streams. The Mourne region stream showed generally improving recruitment patterns (Moneycarragh, Shimna, Kilkeel) except for the Annalong river which showed a reduction in 0+ recruitment. It should be noted, however, that the data for Annalong and Kilkeel rivers was incomplete and patchy with no current survey information available post 2019. The Erne region exhibited strong, statistically significant, positive trends on rivers entering Lower Lough Erne (Garvary, Kesh, Ballinamallard) indicative of good production of young-of-year trout in these systems.

3.2 Trout abundance assessment at long term river monitoring stations.

To assess 0+ trout abundance at FQ electric fishing survey stations a common classification system was required to describe the habitat quality or 'habitat score' at monitored sites. Information was also needed to describe the 'normal' abundance levels expected at each defined habitat grade/score as a benchmark for assessment. A common habitat classification system for trout parr habitat was developed for use on sea trout rivers in the Baltic Sea region (ICES, 2011). This system developed a Trout Habitat Score (THS) based on six common abiotic factors including; width, slope, velocity, depth, substratum and shade. The Baltic THS system was adapted for use in Northern Ireland rivers using 5 important abiotic characteristics including; *width*, *depth*, *flow*, s*ubstratum* and *shade* (DCAL Trout Report, 2011; Table 1). The

suitability of each ranged from 0-2 with 2 reflecting the optimal suitability and 0 describing marginal suitability. The THS for a particular site represents the summation of the suitability scores for each of the 5 abiotic variables, such that the range extends from 0 (not suitable) to 10 (maximum suitability). The THS system was tested against a panel of local FQ electric fishing data for which habitat information was available. This analysis suggested that THS was a good indicator of potential habitat value for 0+ trout parr in Northern Ireland, ANOVA $F_{264}=4.1$, $p<0.001$, and reference abundance levels (n 0+ trout /100m^2) were developed for each habitat score category (DCAL Trout Report, 2011). The abundance of 0+ trout, determined at any given individual FQ monitoring site, can thus be assessed against its relative THS derived reference level.

Table 1. Trout habitat scores for five abiotic descriptors of habitat quality (*adapted from* ICES, 2011).

Abiotic Factors	**Habitat Score**		
	0	***1***	***2***
Wetted width (m)	>10	6-10	<6
Water Velocity (ms^{-1})	<0.2	>0.7	0.2-0.7
Mean Depth (cm)	>50	30-50	<30
Dominating Substratum	Fine	Boulders, bedrock or sand	Gravel-stone
Shade (%)	<10	10-20	>20

A traffic light system was employed to grade the recruitment at each site such that when the midpoint of the 0+ density estimate for a monitoring site was within or above the expected range estimated from the model the site was graded as '*within or above recruitment target'* (green). When the midpoint of the 0+ density estimate for a monitoring site was below the THS range but the upper confidence interval (CI) intersected with that of the THS range the site was graded as '*at risk of falling below recruitment target'* (amber). When the midpoint and upper boundary of the CI for a monitoring site fell beneath the THS range the site was graded as being '*below recruitment target'* (red).

The abundance of 0+ age class trout are determined annually at 6 FQ monitoring sites across N. Ireland. These sites surveyed are located on the rivers Blackwater, Kells (Glenwhirry), Sixmile, Clady (Lower Bann), Garvary (Erne) and Shimna (Fig 2). The THS score has been assessed at each monitoring site and the annual abundance data are scored against the reference levels derived from the model.

Fig 2. Location of Annual FQ electric fishing monitoring sites for 0+ age class brown trout across N. Ireland

Data are currently available for 14 years (2010-2023) for the 6 annual FQ monitoring stations (Table 2). Across all the rivers and years, the most common classification for 0+ trout abundance was '*within or above target'* (c. 70%), indicative of generally good recruitment across the monitored network. The Kellswater (Neagh) showed the highest rate of compliance with c. 85% of monitoring occasions classed as *within or above target*, whilst the Garvary (Erne) showed the lowest rate of compliance with c. 54% of monitoring occasions classed as *within or above target*. The highest annual compliance levels were generally observed on the Kellswater and Sixmile rivers on the Lough Neagh system. These sites are both located adjacent to key spawning habitats for potamodromous Lough Neagh trout (dollaghan) and the

high abundance levels are likely driven by the offspring of migratory females. The Shimna monitoring site was moved in 2023 to a smaller, more manageable site since the previous site had widened after several high flood events.

Table 2 The relative compliance (%) against Trout Habitat Score (THS) abundance targets for 0+ trout at monitoring sites across Northern Ireland.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Blackwater	307	155	152	303	69	226	107	249	70	51	63	105	36	112
Kells	127	102	58	156	436	309	136	137	510	287		155	266	51
Sixmile	249	210	42	105	288	176	122	133	230	93	86	281	81	152
Clady	130	102	115	188	142	130	120	90	211	59		268	112	81
Garvary	62	84	65	115	184	100	168		162	27	80	237	177	74
Shimna	83	48	148	100	187	122		99		85				366[1]

3.3 Trout Monitoring in Northern Ireland Lakes.

Brown trout are surveyed in Lough Neagh (2011-2022) and in Lough Erne (1992-2022). The Neagh surveys are conducted via draft netting hauls to produce an index of relative abundance (number of trout/m^2) whilst the Erne surveys utilise multi-panel survey gill nets to produce a similar Catch per unit effort (CPUE) index (number trout/m).

[1] Shimna monitoring site moved in 2023 from Tipperary Wood to the Burrendale corner.

The Lough Neagh data indicated a decrease in CPUE in recent years with the 2022 level the lowest in the current time-series (Fig 3). An important caveat behind these data is that the overall catchability of fish within Lough Neagh may have decreased in recent years due to increased water clarity, driven by filter feeding invasive zebra mussels. Comparison of inter-annual CPUE time-series data relies on consistency in key factors such as methodology and catchability, such that recent low estimates may be biased and represent an artefact of fluctuating environmental conditions. Further calibration work is required to determine the impact of clearer water on fish catchability to assess how the observed declines in CPUE relate to the overall trout stock.

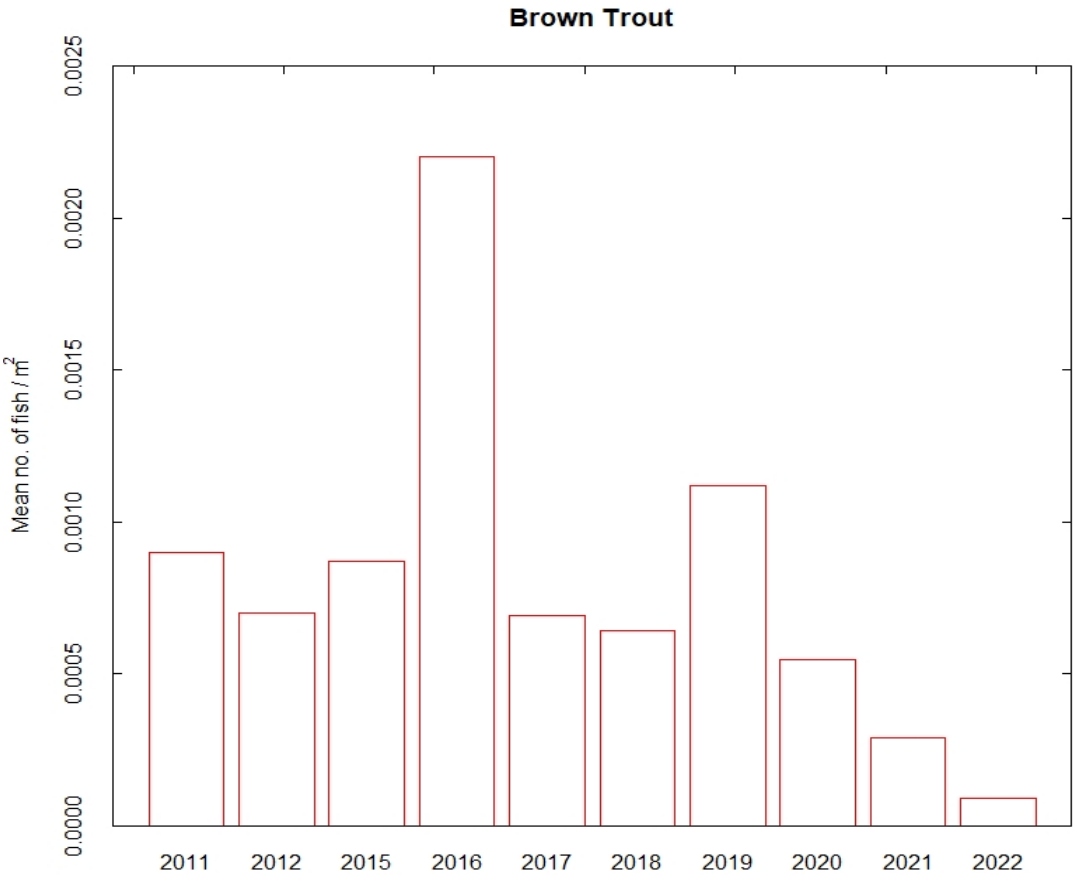


Fig 3 CPUE of brown trout captured in draft net surveys (autumn) in Lough Neagh 2011 - 2022.

The Lough Erne survey occurs every three years and a 30 year time-series is now available for the lake (1992-2022). The CPUE of trout in Lower Lough Erne, measured via multi-panel gill nets, declined post 2010 although a modest improvement was observed in the latest survey in 2022 (Fig 4). This time-series has been constructed from survey nets set at a standard sample of fixed stations around the margins of the Lough (Rosell, 1994). It should be noted that this survey does not cover the deeper, offshore portions of the lake and therefore may not fully reflect the overall trout stock present within Lower Lough Erne. Recent telemetry studies in which adult trout were tagged and tracked in Lough Erne (see section 6.4) have indicated that many lake dwelling trout will actively utilise deeper parts of the lake through-out the year. More work is ongoing to investigate and develop deep water survey techniques to sample trout.

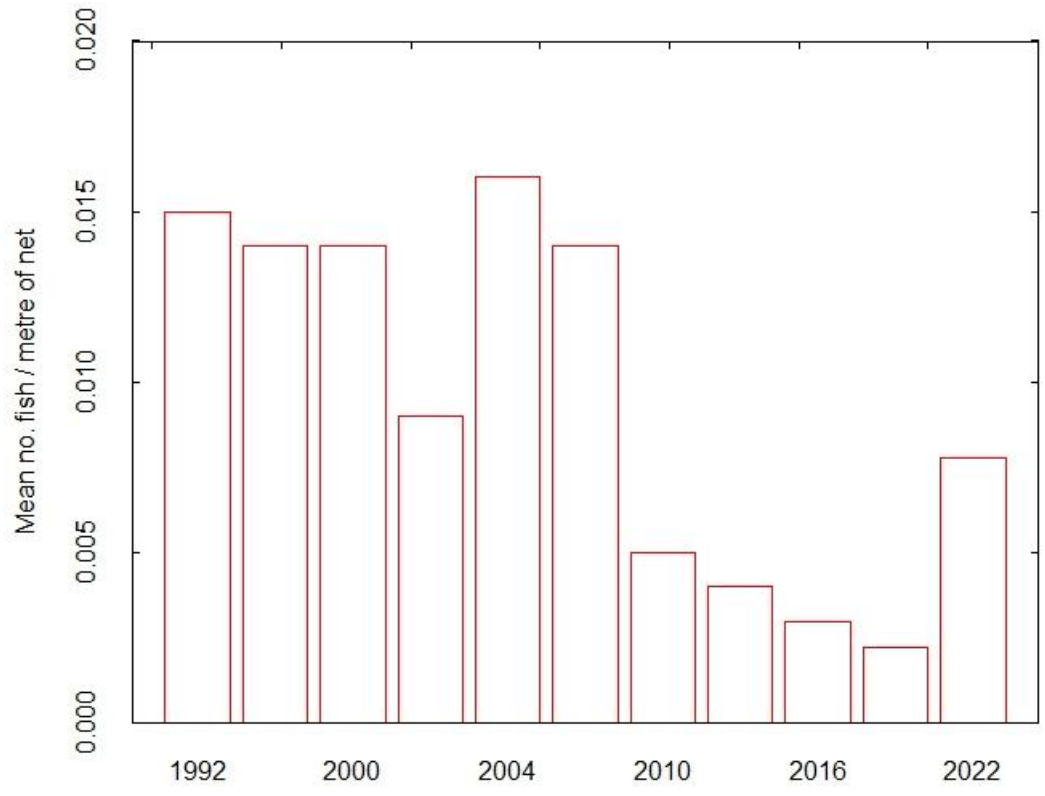


Fig 4 CPUE of brown trout captured in multi-mesh monofilament survey nets (summer) in Lower Lough Erne 1992 - 2022.

4 Summary & Recommendations

- SQ electric fishing data provided an overview of juvenile recruitment in each monitored river over a longer period (15 years +), equivalent to several trout generations. Most populations (apart from those in South-East Antrim) indicated stable or increasing trends across the available time-series.
- SQ electric fishing data from South-East Antrim showed a negative trend across all 3 monitored rivers. This common trend (across all 3 rivers) may be suggestive that shared factors could be driving recruitment at a regional scale. Further investigation of the factors potentially limiting trout recruitment in this region is warranted.
- FQ electric fishing data conducted at 6 monitoring stations across N. Ireland indicated that trout were predominantly classed as 'within or above target'. The Kells water and Clady rivers scored highest and complied or exceed target on 85% and 77% of respective monitoring occasions.
- Survey netting catch-per-unit-effort (CPUE) indices of relative trout abundance on Lough Neagh has shown a decline in recent years. It is not clear whether this is due to declining stocks within Lough Neagh or is a consequence of decreased catchability of trout in survey nets due to increasing water clarity.
- Survey netting CPUE indices of relative trout abundance on Lower Lough Erne have declined post 2010, although a modest improvement was observed in the latest survey (2022). Further work is recommended to extend the trout survey to include deeper, offshore waters.

5 New Sea Lice Monitoring Programme on Sea Trout

DAERA Inland Fisheries Group commissioned AFBI to survey, assess and document sea lice levels on wild salmonids from representative coastal rivers in Northern Ireland. This request stemmed from recommendations from the North Atlantic Salmon Conservation Organisation (NASCO) encouraging member jurisdictions to better monitor/assess sea lice loads on wild anadromous salmonid populations in coastal streams.

Two study rivers were selected to trial this work. The Glenarm River in Co. Antrim which is geographically proximate to the main salmon aquaculture production facilities in N. Ireland and the Shimna River in Co Down which was selected as a control site on which to assess natural background lice loads. Previous telemetry research conducted under the INTERREG VA funded COMPASS project showed that Shimna post-smolt sea trout did not venture north of Belfast Lough and consequently remain distant from any aquaculture production facilities, such that they should reflect natural background sea lice levels.

Early returning seatrout finnock (x.0+ sea age) were chosen as a sentinel species for sea lice monitoring for several reasons. Firstly, they are relatively abundant and thus could be practically sampled from both survey catchments. Secondly, finnock can be sampled when freshly run from the sea by surveying the lower tidal river sections and targeting fish soon after they enter the river from the sea (i.e. whilst brightly silvered and carrying lice). Lastly, sea trout post-smolts exhibit more local migratory habits than salmon, frequenting coastal areas where they may interact with inshore anthropogenic activities, and hypothetically may incur greater interaction with coastal activities such as aquaculture.

A pilot survey was conducted in August 2022 on the Glenarm River and again in July 2023 on both the Glenarm and Shimna rivers. The lower tidal section was electrofished using 3 e-fish backpacks fishing into a stop net fixed across the end of the survey stretch. This technique ensured greater sampling efficiency and maximised the chances of sampling finnock from these relatively limited (spatially) sites. After capture by electric fishing, sea trout were rapidly transferred to a large 100L holding tank then immediately measured for Length (cm), Weigh (g), assessed for run status (1-4 scale; 1= bright sliver – 4 = dull brown) and predator marks, before a visual count of sea lice was undertaken. The sea lice count included all visible life stages of *Lepeophtheirus salmonis*. The results from these surveys are documented below (Table 3).

Table 3 Sea trout sampling in 2022-23 indicating mean biological characteristics and mean sea lice counts.

River / Year	No Finnock Sampled	Mean L_F (cm)	Mean Weight (g)	Mean CF (Fultons Index)	Run Status	Mean Lice Count/fish (*range min-max*)
Glenarm 2022 (Pilot)	19	27.1	**214**	**1.08**	**2.3**	**1.63** (*0-11*)
Glenarm 2023	11	27.2	**253**	**1.21**	**1.5**	**2.55** (*0-10*)
Shimna 2023	8	27.7	**261**	**1.22**	**1.5**	**1.88** (*0-12*)

Comparison of the Glenarm and Shimna rivers showed no significant difference in lice counts between the two systems in 2023 (Mann Whitney U Test; U value=29; z-score=1.197; p=0.23). The number of sea lice counted on individual fish ranged from 0-10 in Glenarm and 0-12 in Shimna in 2023. Both stocks exhibited similar lice frequency distributions with the most frequent classification across all sites being 0 lice (Fig 5). The condition factor of sea trout across the Glenarm and Shimna was virtually identical in 2023, perhaps indicative of similar coastal feeding opportunities across both stocks (Fig 6).

- *Finnock appear to represent a convenient sentinel species and it is recommended that this work be continued in future years to increase the available sample size, examine the variability of sea lice abundance on local sea trout and develop a time-series.*

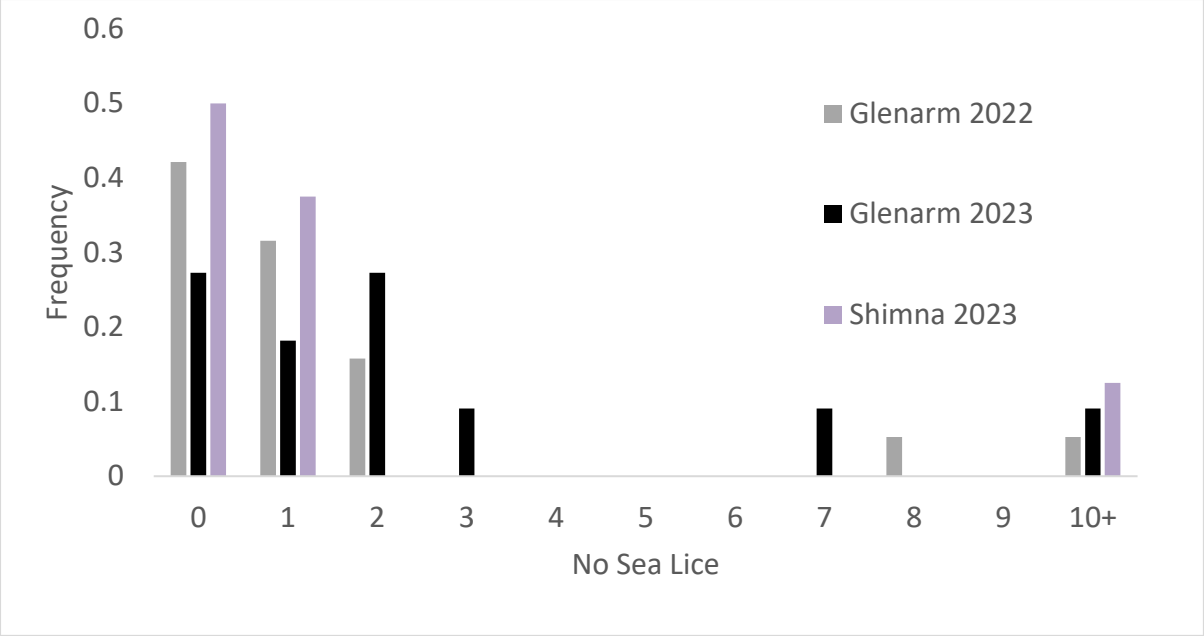


Fig 5 The sea lice load (frequency) on sea trout samples from 2022-23.

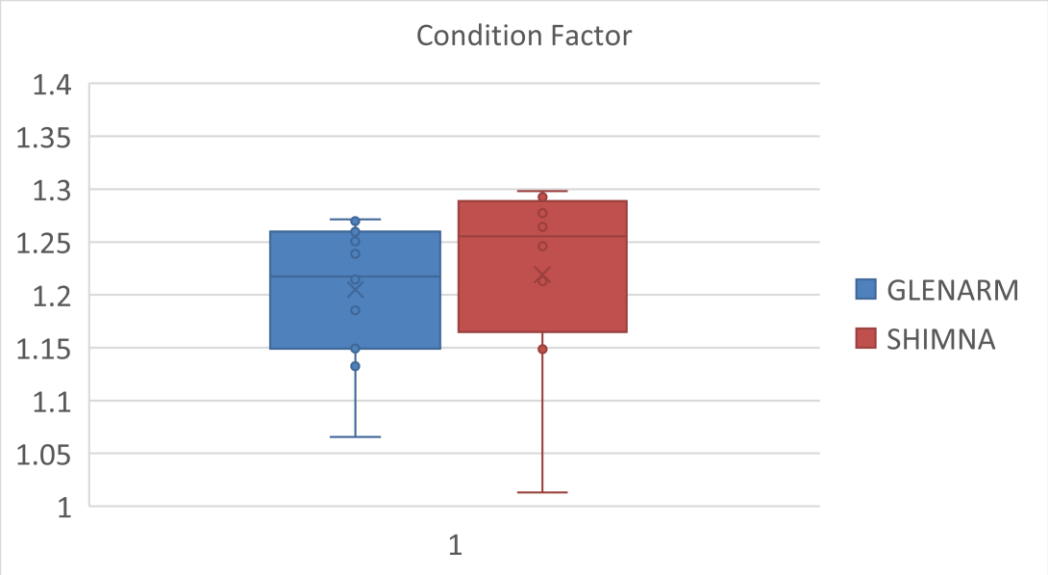


Fig 6 The condition factor (Fultons Index) recorded on summer sea trout samples from 2023.

6 Citizen Science Initiatives; Angler Scale Collection Programmes

6.1 Introduction

Staff from AFBI Freshwater Fisheries engaged with anglers on the Sixmilewater River, County Antrim in 2022 with a view to pilot a citizen science project focusing on obtaining scale samples from angler caught dollaghan trout on the river. This project aimed to utilize the assistance of anglers on the river's prolific recreational fishery to collect a large sample of dollaghan scales for ageing in order to further supplement AFBI's long term monitoring data on the river.

6.2 Methods

AFBI Freshwater Fisheries provided scale sampling kits to coordinators within both angling clubs on the Sixmilewater river, Ballynure Angling Club and Antrim & District Angling Association. The sampling kits were distributed to anglers at the beginning of summer 2022 ahead of the main Dollaghan run. Anglers were asked to record fork length (cm) and species of fish, as well as date of capture on each of the scale envelopes.

Scale sample envelopes complete with associated biological data, were returned to AFBI by the angling club coordinators for processing following the close of the game angling season. Scales were then read, with suitable samples providing age and where possible, a spawning history of the fish caught.

6.3 Selected Results/Data

A total of 113 scale samples were collected from Dollaghan caught by anglers on the Sixmilewater River from July to the end of October 2022. Of these samples, 97 were suitable for reading and were successfully aged. The smallest Dollaghan sampled was 29cm, with a fish at 81cm being the largest and a length-frequency plot of the population indicated a modal length of 46 cm (Fig 7). A small number of anglers also weighed their fish which allowed condition factor to be calculated for a sub-sample of fish (n=7) (Table 4). Future analysis will focus on the age distribution of the stock and facilitate investigation of life-history strategy.

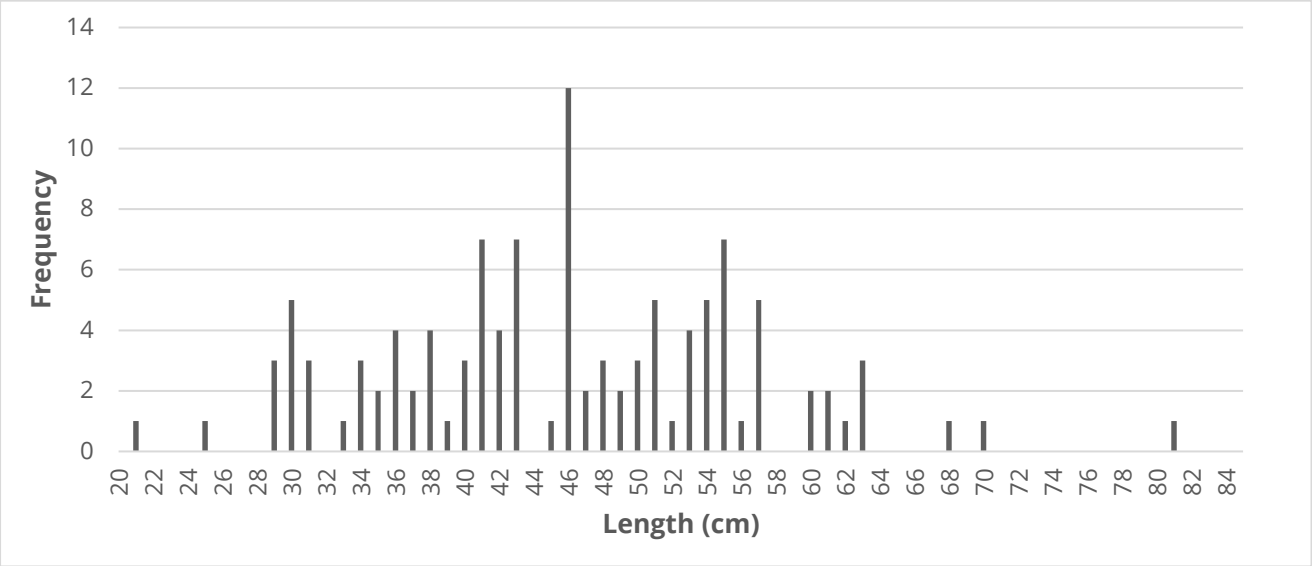


Fig 7 Length Frequency distribution of dollaghan sampled by anglers on the Sixmile in 2022.

Table 4. Biological characteristics and age of Sixmile dollaghan sampled by anglers in 2022.

Length (cm)	Weight (g)	Condition Factor	Age (Years)
41	700	1.02	5+
42	620	0.84	5+
50	1360	1.09	-
51	1300	0.98	4+
53	1840	1.24	4+
55	2040	1.23	5+
70	5480	1.60	6+

6.4 Discussion

This collaborative citizen science project between AFBI and anglers on the Sixmilewater River (Fig 8) proved to be successful in gathering a large number of scale samples for reading and ageing.

Preliminary data were presented to both angling groups through presentations at annual general meetings in early 2023 which led to useful discussions and the further exchange of information and insights between AFBI scientists and anglers. Anglers involved in the pilot on the Sixmilewater are keen to learn more from the data they helped to collect, and as a result AFBI have been invited back to an AGM meeting in January 2024 to present the remainder of the findings from the full data set following full processing and analysis.

This pilot demonstrated that there are opportunities for scientists and anglers to work collaboratively where there is a shared vested interest which can yield positive and useful results. Since the successes of this pilot, AFBI scientists have visited another angling club on the Lough Neagh system with a view to carrying out a similar project.


Fig 8. Dollaghan sampling by Sixmile anglers.

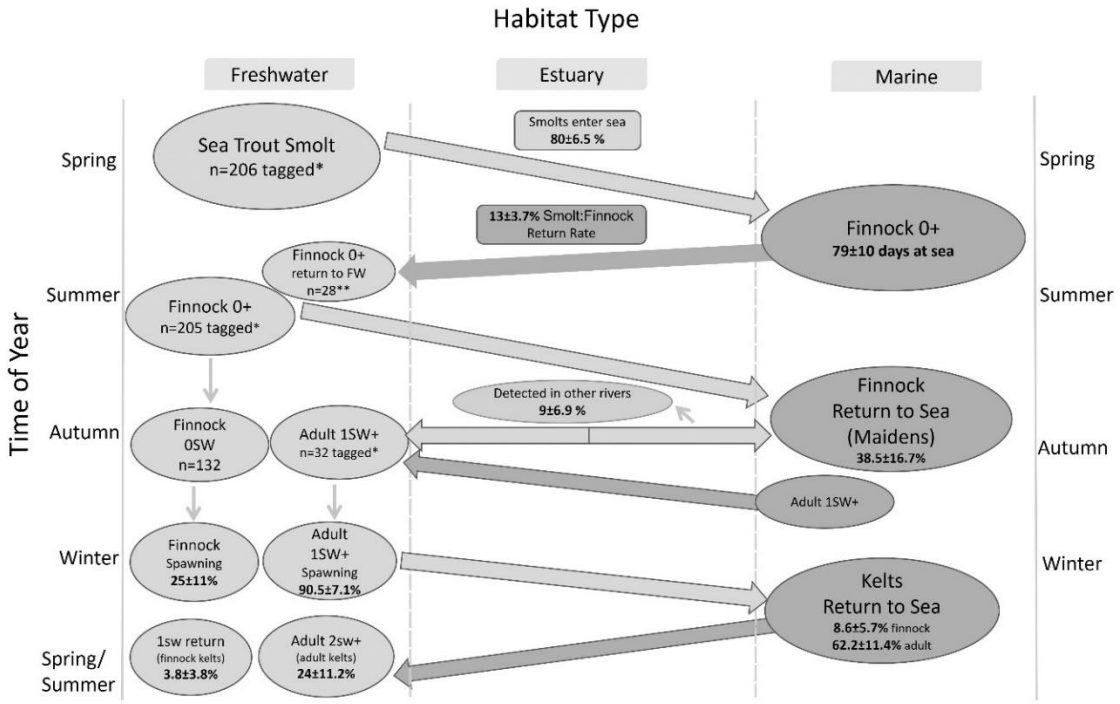
7 AFBI Trout Research Summary

A number of research projects, focused on trout, have been completed since the last trout report in 2011. A brief summary of each project, the main aims, findings and selected results have been compiled in the following section.

7.1 COMPASS Project, Acoustic telemetry studies on Mourne area sea trout stocks.

Background.

The COMPASS project provided a collaborative, cross-border, platform to undertake fundamental research on sea trout behaviour, survival and return rates in rivers around Co Down and Co Louth. Various age classes of sea trout (smolts, finnock, and adults) tagged in the Shimna and Castletown rivers, were tracked via networks of acoustic receivers planted along the coast and data was collated on migratory success, survival, timing and subsequent return rates. The Flow diagram below shows the mean survival levels and behaviour choices of different age classes of tagged sea trout (from Kennedy *et al*. 2022).



Key Findings.

- Post smolt sea trout undertook variable migration strategies with some fish moving long-distances and across regions/borders (e.g. several smolts tagged in the Shimna were detected in the Boyne estuary during the summer). Management strategies must consider these extensive migratory behaviours.
- Smolt survival was related to size with large smolts surviving better than smaller individuals.
- Finnock (early freshwater return) behaviour was common in Mourne stocks but only a minor proportion of finnock (c. 30%) migrated upstream to spawn.
- Annual adult sea trout survival rates varied from 9-40% on the Shimna river.

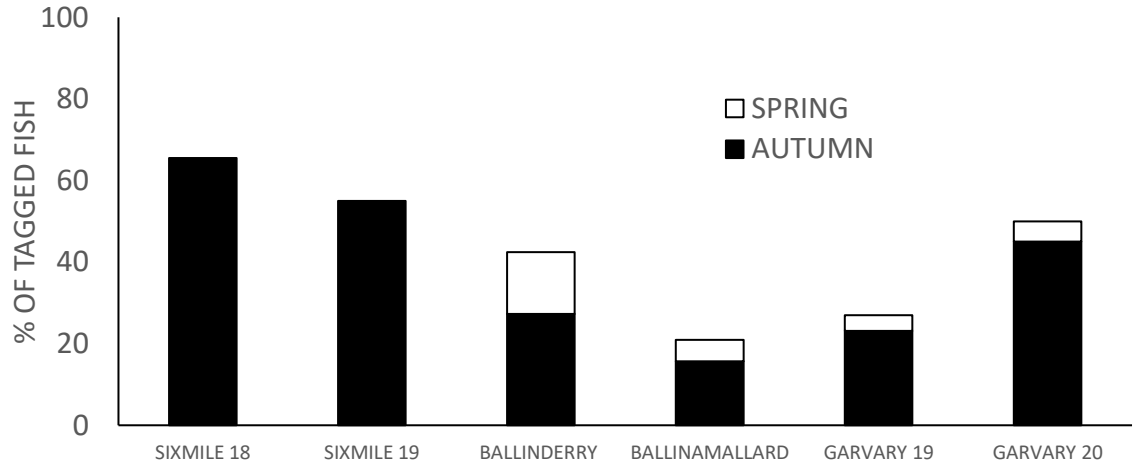
Reference/Further Reading

Kennedy, R.J., Barry, J., Roche, W., Rosell, R. & Allen, M. (2022). In-river behaviour and freshwater return rates of sea trout, *Salmo trutta* L., from two coastal river populations. *Journal of Fish Biology*, **101**, 1008-1020.

7.2 Assessment of phenology patterns in potamodromous trout parr in Loughs Neagh & Erne.

Background

This study used acoustic telemetry to examine the phenology (migratory timing), behaviour and survival of potamodromous trout parr across two large N. Ireland lake catchments (Loughs Erne & Neagh). Between 2018-2020 a total of 167 trout parr were tagged in late summer across 4 lake tributaries including the Ballinamallard and Garvary rivers (both within the Erne catchment) & the Sixmile and Ballinderry rivers (both within the Neagh catchment). The bar chart below shows the migratory timing (Autumn or Spring migration into lake) of trout parr tagged in the summer across various tributaries of Loughs Erne and Neagh.



Key Findings.

- Most parr which migrated downstream, moved into their respective lake during the Autumn (Oct-Nov). Across all samples 89% of fish moved in Autumn and 11% moved in the Spring.
- Management challenge to protect autumn migrants given historical legislative bias to the spring period.
- Autumn migrants migrated during higher flows than spring migrants.
- Longer term survival was higher in Lough Neagh than Lough Erne.

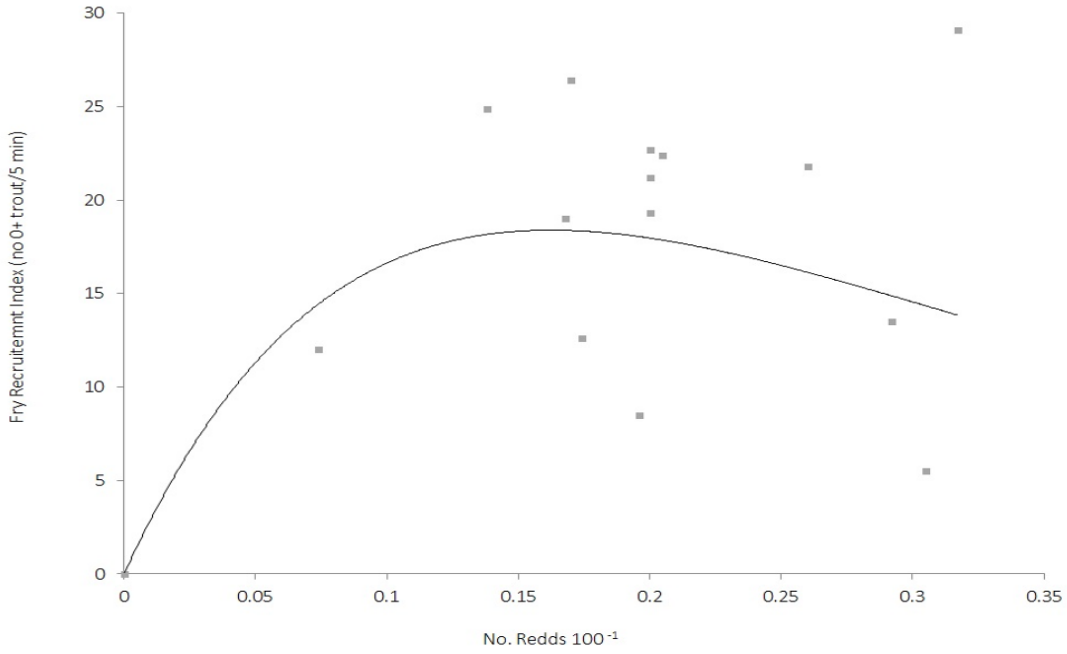
Reference /Further Reading

Kennedy, R. J., Rosell, R. & Allen, M. (2022). Investigating the phenology of juvenile potamodromous brown trout (*Salmo trutta* L.) in two large lake catchments. *Journal of Fish Biology*, **100**, 697– 704.

7.3 Assessment of long-term data on trout abundance in Lower Lough Erne.

Background

This research tabulated historical data on trout abundance in Lower Lough Erne, including long term time series on redd counts in several spawning rivers. Analysis indicated that redd counts were significantly lower for the post-zebra mussel time-series (2000–16) than the pre-zebra mussel time-series (1968–99). Juvenile densities in the spawning tributaries, however, had not declined, and a functional stock-recruitment relationship was observed between adult spawners and young-of-year juveniles. The graph below shows the stock-recruitment relationship (Ricker Curve) between Spawners (redds) and recruits (fry) for the Garvary river.



Key Findings.

- Redd counts across Ballinamallard, Kesh and Garvary rivers indicated two periods of reduced abundance. The first was associated with UDN disease in the late 1960's and the second associated with zebra mussel invasion post 1999.
- Juvenile recruitment had not declined across the overall time period, likely as a consequence of the stock-recruitment relationship between spawners and recruits at a catchment scale.

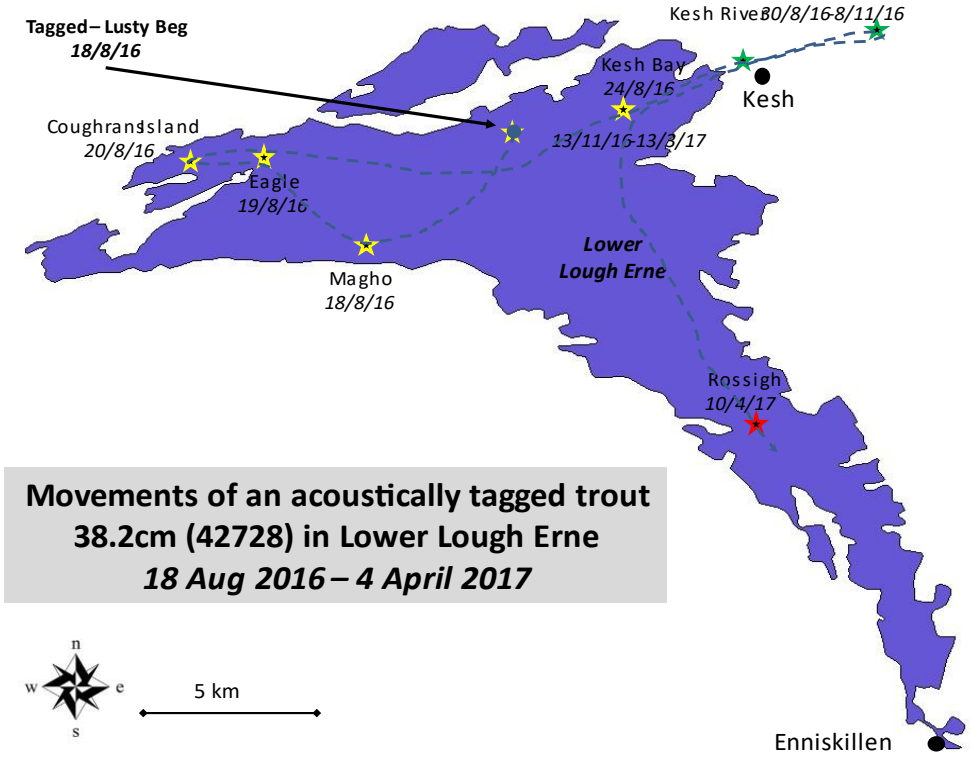
Reference /Further Reading

Kennedy, R.J., Rosell, R., McElarney, Y., M. Allen & Gallagher, K. (2021). Long-term abundance patterns of potamodromous brown trout in a large lacustrine catchment in County Fermanagh. *Biology and Environment: Proceedings of the Royal Irish Academy*, **121b,** 133-145.

7.4 Telemetry studies on Lough Erne Brown Trout

Background

Acoustic telemetry was utilised to track a sample of 80 adult wild brown trout across an extensive array of 30 receivers in Lower Lough Erne during 2016 and 2017. The fish were mainly captured by anglers in the lake and the study aimed to investigate behaviour, movement patterns and identify which lake tributaries fish utilised by spawners. The map below shows the detections of a tagged brown trout in Lower Lough Erne between August 2016 and April 2017.



Key Findings.

- Larger trout survived better than smaller individuals.
- The Ballinamallard river was the most commonly used spawning tributary by tagged trout.
- A high proportion of tagged trout did not spawn and remained in the lake.
- In total 9 trout were re-captured by anglers between 2-1152 days post-tagging, with a mean liberty time of 152 days, and a minimum angling exploitation rate of 11.25%.

Reference /Further Reading

Kennedy, R.J., Rosell, R. & Allen, M.M. (2021). Some observations on the behaviour of lake-dwelling brown trout in Lower Lough Erne. *Biology and Environment: Proceedings of the Royal Irish Academy*, **121B**, 1-8.

7.5 Analysis of angling catches on the Shimna river and implications for fishery management

Background

The ability of rod catch to adequately reflect the size and age composition of a migratory fish stock within a river is an important consideration for stock assessment. Sea trout sampled from the rod fishery in the Shimna river were compared against fishery independent samples captured by electric fishing. The photo below shows adult sea trout captured from the Shimna river.

Key Findings.

- The Shimna rod catch was dominated (>90%) by .0+ sea age finnock < 38 cm L_F
- The size structure of rod caught fish was statistically reflective of comparative samples obtained by electric fishing from the lower (tidal) river.
- Sea trout electric fished from upstream spawning areas however contained < 40% finnock and the size structure differed significantly from the rod caught sample.
- The potential reasons for differential distribution of sea trout age classes within a small coastal river are discussed in conjunction with the implications for stock assessment and fishery management.

Reference /Further Reading

Kennedy, R.J. & Rosell, R. (2020) Does rod catch reflect the background size structure of the sea trout stock in a small coastal river? *Fisheries Management & Ecology*, **28**, 167– 171.

8 Future Opportunities & Research Requirements.

8.1 Biological Reference Points

Stock-recruitment curves describe the relationship between spawner density and resultant recruitment in a fish population. The development of a Stock Recruitment (SR) relationship for a salmonid population allows the derivation of Biological Reference Points (BRP). For example, the asymptote of a SR curve indicates the stock level at which maximum recruitment is attained. Stock recruitment curves have been used to set reference points for the management of salmon populations and international efforts are ongoing through ICES to further investigate and develop SR relationships and BRPs in sea-trout stocks (https://www.ices.dk/community/groups/Pages/WGTRUTTA.aspx).

Some valuable BRP research has been conducted in N. Ireland on the Shimna river sea-trout stock and it is hoped this work will contribute to international efforts to assess and manage trout stocks (Kennedy *et al*., 2017).

8.2 Stock Assessment.

Research on the Shimna river (see Section 6.5) has shown that rod catch can reflect the available background stock of migratory trout in a fishery. Consequently, there is significant potential to collect valuable conservation information on trout stocks using rod catch statistics collated by angling groups.

8.3 Predation.

Concerns continue to be expressed by numerous stakeholders on the potential impact of predation on some trout stocks, through-out the life-cycle of trout and across a range of

predators. New tools are being developed (e.g. predation sensor acoustic tags) which should be applied to local trout stocks in order to quantify and assess putative predation driven mortality.

8.4 Genetics.

Developments in genetic science have increased the scope and resolution of genetic studies. Potential future research could be used to examine the effective population size of sea-trout stocks, determine the contributing stocks in Mixed Stock Fisheries (MSF) and outline the genetic population structuring within river catchments (Keenan *et al*., 2014).

8.5 Enhancement.

Local stakeholders, angling clubs and DAERA have all undertaken habitat restoration projects to enhance trout stocks. Some research was conducted in N. Ireland which has demonstrated the value of habitat restoration works (Kennedy *et al*., 2014), however, further effort should be invested to monitoring enhancement efforts pre- and post- works to advise and refine future investments.

8.6 Climate Change

Future climate change senarios may present a range of challenges and opportunities for local trout stocks (e.g. altering phenology and growth rates). A local focus on the key challenges facing trout populations in N. Ireland is warranted with a management focus on potential mitigation options.

8.7 Invasive Species

A range of invasive species have been identified in N. Ireland waterways over recent decades with some examples including zebra mussels and pink salmon. The potential implications for trout conservation and management are wide-ranging and require future research efforts.

8.8 Other Issues

A range of other issues require further research work within the DAERA area. These include an examination of the potential consequences of water abstraction on trout populations, the possible implications of blue-green algae blooms on local stocks and the implications of catch and release for trout stocks.

9 References

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