IFI/2014/1-4240

Report on Salmon Monitoring Programmes 2013 funded under the Salmon Conservation Fund

November 2014

IASCACH INTÍRE ÉIREANN
INLAND FISHERIES IRELAND

Report on Salmon Monitoring Programmes 2013 funded under Salmon Conservation Fund

November 2014

Report on Salmon Monitoring Programmes - 2013

Salmon Monitoring: Report on projects to assess attainment of Conservation Limit for Atlantic Salmon in Irish Rivers

Project Personnel

This report was written and researched by P. Gargan, PhD and W. Roche PhD of the Salmonid Section, Research Division of Inland Fisheries Ireland and Tony Holmes M.Sc.

Acknowledgements

Much of the catchment wide electro-fishing programme was undertaken by the staff of the River Basin Districts (formerly the seven Regional Fisheries Boards). The excellent contribution and cooperation of the staff of each of the Boards during the fieldwork element of these projects is greatly appreciated.

Thanks are due to Nigel Bond (Marine Institute) for technical support on the Boyne telemetry project and to the Irish Air Corps for supporting aerial monitoring of tagged salmon in the catchment in 2013.

Contents

Executive Summary

- Funding was provided under the Salmon Conservation Fund to assess the status of salmon in selected catchments. There were three separate elements in the 2013 programme - **Catchment-wide Electro-Fishing, Development of a raising factor for a partial counter facility and Determination of the life history characteristics of adult salmon in selected catchments.**

- The objective of the catchment-wide (CW) electro-fishing programme is to develop an index of juvenile salmon abundance to support assessment of attainment of salmon conservation limits (CL) on individual rivers. Salmon conservation limits (the number of adult salmon required to spawn to maintain the population), or, as defined by NASCO as "the spawning stock level that produces maximum sustainable yield", were set for 148 Irish salmon rivers (SSCS 2005).

- Catchment Wide electro-fishing was completed in 34 catchments in 2013 to assess abundance and distribution of salmon fry. A total of 787 sites were visited. In the first six years of the programme (2007-2013) 274 catchment surveys in 127 catchments have been undertaken comprising 5745 individual site surveys.

- A precautionary approach was adopted by the SCCS (2009) for the provision of catch advice using the 2007, 2008 and 2009 catchment-wide electro-fishing results. After data analysis, the threshold catchment-wide value was lowered from 25 salfry/5mins (2007 & 2008) to 17 salfry/5mins as a cut off point for identifying rivers likely to be meeting CL. The analysis found that the majority of the rivers known to be meeting and exceeding CL had a fry index of 17 or higher.

- This threshold value of 17 salmon fry was suggested by the SSCS as a qualifying value for a river to operate on a catch and release basis. This applied to rivers where information on CL attainment levels was limited or insufficient. Where more than one year's fry indices were available, the catchment mean should ≥ 17 salmon fry.

- Seven rivers which were predicted to have an adult salmon deficit in 2013, but which supported a salmon fry index ≥ 17 over the 2009-2013 period were recommended for opening on a catch & release basis in 2014. Catch and release angling provides catch data which allows for estimation of stock size. The rivers were Owenagarney, Bungosteen, Carrownisky, Owenascaul, Owenwee (Yellow), Milltown (Kerry), Cloonee.

- For the 34 salmon catchments surveyed in 2013, salmon fry abundance for **this year alone** ranged from an average of zero fry on the Erne, to a catchment average of 33.06 fry on the Cloonee. The Bungosteen, Swilly, Carrownisky, Leannan, Owenwee (Yellow), Castletown, Feale, Owenmore, Erriff and Cloonee all recorded an annual catchment wide average of >17 fry. Salmon fry abundances >15 Salfry/5 min were also recorded on the Clooghnamore, Owenascaul, Owenagarney and Bungosteen catchments.

- Generally there was good agreement between the Standing Scientific Committee scientific assessment of attainment of salmon conservation limit from rod catch or counter data and the results of the catchment-wide electro-fishing surveys. However, some rivers, primarily

small rivers with an annual rod catch < 10 adult salmon were, based on electro-fishing results, very unlikely to be meeting their derived CL (e.g. Adrigole and Carhan).

- Results to date indicate that the catchment wide electro-fishing technique has good potential for salmon stock assessment. It is anticipated that at least 5 years data from many different catchments will be required before meaningful relationships between juvenile abundance and conservation limits can be developed. The technique is likely to provide the best estimate of salmon stock status in small rivers where historical rod catches were low (<10 salmon annual rod catch) and could not be used to estimate salmon stock size currently.

- CW electro-fishing is also important in providing managers with detailed information on salmon fry distribution and abundance. The absence or low density of salmon fry may be related to water quality issues, obstructions, or habitat damage and areas of low abundance can be investigated. These data should be used to target any remediation works that may be required.

- The partial counter at Blackcastle weir on the River Boyne counts a proportion of the annual adult salmon run. An unquantified proportion ascends uncounted over the "open" part of this weir. A raising factor, based on historical data, is applied to the count. To refine this raising factor a five year telemetry study, which commenced in 2010, has been undertaken. Adult salmon, captured by traditional draft net fishermen, under the supervision of staff from IFI Drogheda are tagged in the Boyne estuary. In 2013 a total of 222 fish were PIT tagged between July and August. Only 1 PIT tagged fish was detected at Blackcastle; low water levels and high temperatures over the summer period may have influenced migration patterns. Some PIT tagged fish were also radio tagged to determine the proportion of fish migrating to and above Blackcastle weir and to develop an understanding of migration patterns and timing within the river. A full analysis of all data is ongoing to develop a raising factor model.

- Salmon scales were collected and analysed for life history information from the commercial fishery on the Munster Blackwater, Nore and Suir and rod fisheries on the Owenmore River (Connemara) and Sneem River (Co. Kerry). The proportion of fish of various life histories varies greatly between catchments. There appears to be a pattern with catchments on the west coast having a higher proportion of grilse than those on the south and east coast. The Munster Blackwater recorded 60% grilse, 37% multi sea winter (MSW) and 3% previous spawners. The river Suir recorded 46% grilse, 49% MSW and 5% previous spawners while the river Nore recorded 35% grilse, 52% MSW and 13% previous spawners. The Owenmore (Ballynahinch River) was dominated by one sea winter fish (87%) with 13% MSW and no previous spawners while the Sneem recorded 53% grilse and 47% MSW.

1. Assessment of Attainment of Conservation Limits for Atlantic Salmon in Irish rivers in 2013: Report on Activities.

1.1. Introduction

In spring 2009, scientists from the Standing Scientific Committee of the National Salmon Commission identified appropriate methods for assessment of attainment of salmon conservation limits (CL) on an individual river basis nationally. They also proposed a strategy for prioritisation of rivers for assessment of attainment of Conservation limits. This assessment was based on the feasibility of inserting new counters, utilising redd counts, using electro-fishing as an index of spawning, determining full counts from partial counters using telemetry based methods in catchments and was linked to understanding the current status of salmon stocks in each river (Anon 2009). Other data such as salmon rod catch, commercial catch by river, micro-tagging data, marine survival and fishery exploitation data are used annually by the Standing Scientific Committee to assess salmon stock status.

This report presents the results of activities undertaken in 2013 to assess attainment of salmon conservation limits nationally in line with assessment methods identified by the scientists.

Inland Fisheries Ireland made an application to the Salmon Conservation Fund for funding for 2013 to assess attainment of salmon conservation limits nationally and €99,000 was provided for this project in 2013. The project had three elements:

1. Catchment wide Electro-Fishing Programme.

Undertake catchment-wide electro-fishing in selected catchments to assess abundance and distribution of salmon fry and to further develop an index of juvenile salmon abundance which can be used to assess attainment of salmon conservation limit. Resources and training in the catchment wide electro-fishing technique were also provided to IFI staff nationally.

2. Development of a raising factor for upstream counts at partial fish counters

Several existing fish counters are partial counters, i.e. they only cover a portion of the river and only count part of the salmon run. Examples include the Slaney, Blackwater, Bandon and Corrib where counters are usually located at the head of fish passes or traps. The recorded count on these rivers is raised by a factor to provide an estimate of the total upstream run. This project was designed primarily to refine the raising factor for the River Boyne counter and to assess the feasibility of using telemetry to assess the efficiency of other partial counters. This work has progressed on the Boyne since 2010 and was continued on the Boyne in 2013 to develop more robust data sets.

3. Biological Assessment of Salmon Populations

Knowledge of salmon life history strategies is required to understand and model salmon populations in different systems. Biological data on salmon including sea age, run-timing, sex ratio and fecundity are necessary to understand population dynamics within a river. Changes to any of these inputs can influence the outcome of the production models used to predict the likely returns to a river and potential fishery performance. Life history traits such as smolt age, sea age, growth and frequency of spawning can be determined from scale reading. Combined with data on time of entry into the system, sex ratio and fecundity, which can be collected from any killed fish, the often complex make up of a population can be established and the models can be adjusted accordingly. Scales were collected from a range of commercial and rod fisheries in 2013.

2. Catchment-Wide Electrofishing Programme 2013

2.1.1. Sampling Methodology.

The sampling methodology was similar to that described in Gargan, P., Roche, W., Keane, S. & Stafford, T. 2008, Report on Salmon Monitoring Programmes 2008 (June 2009), Central & Regional Fisheries Board.

2.2. Results 2013.

During 2013 a total of 34 salmon catchments were surveyed nationally; partial surveys were undertaken on 4 other catchments; 787 sites were visited.

The results for 2013 are summarised in Table 3.2.1 and Charts 3.2.1 and 3.2.2 and Map 3.2.1. The mean salmon fry abundance is presented in table 3.2.1 for all years, where data are available, and the catchments where abundance is >17 fry are highlighted. Ten catchments surveyed in 2013 had a catchment wide salmon fry abundance over all surveys of 17 fry or greater: Owenmore, Castletown, Cloonee, Feale, Erriff, Bungosteen, Milltown, Owenascaul, Owenwee and Owenagarney.

Seven rivers predicted not to have an adult salmon surplus in 2013 and which had an average salmon fry index ≥ 17 over the 2009-2013 period were recommended for opening on a catch & release basis in 2013; catch and release would provide rod catch data for estimation of stock size in the subsequent year. The rivers were Owenagarney (index =16.97 Salfry/5min), Bungosteen, Carrownisky, Owenascaul, Owenwee (Yellow), Milltown (Kerry), Cloonee.

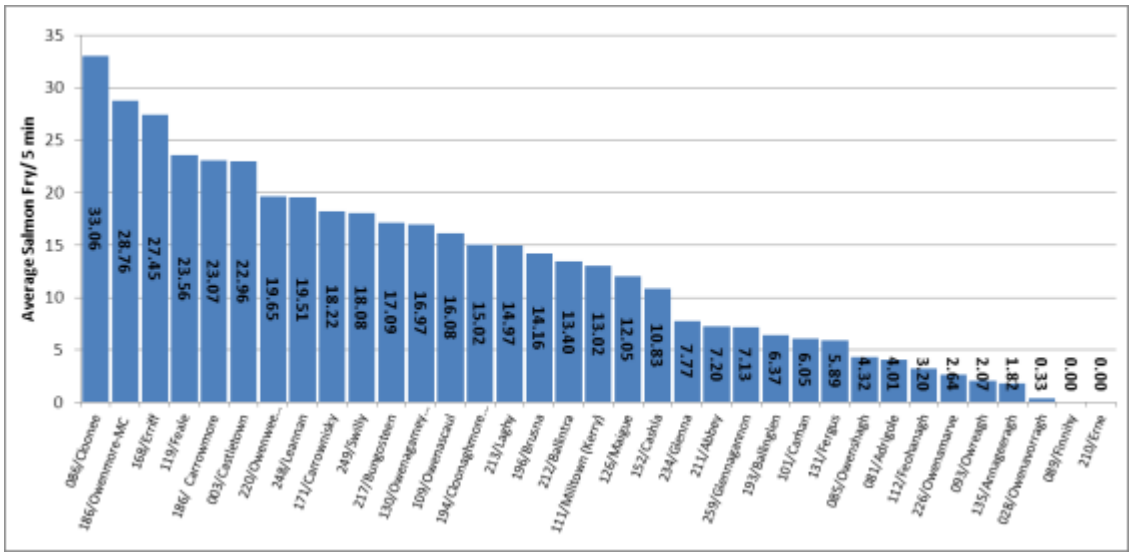
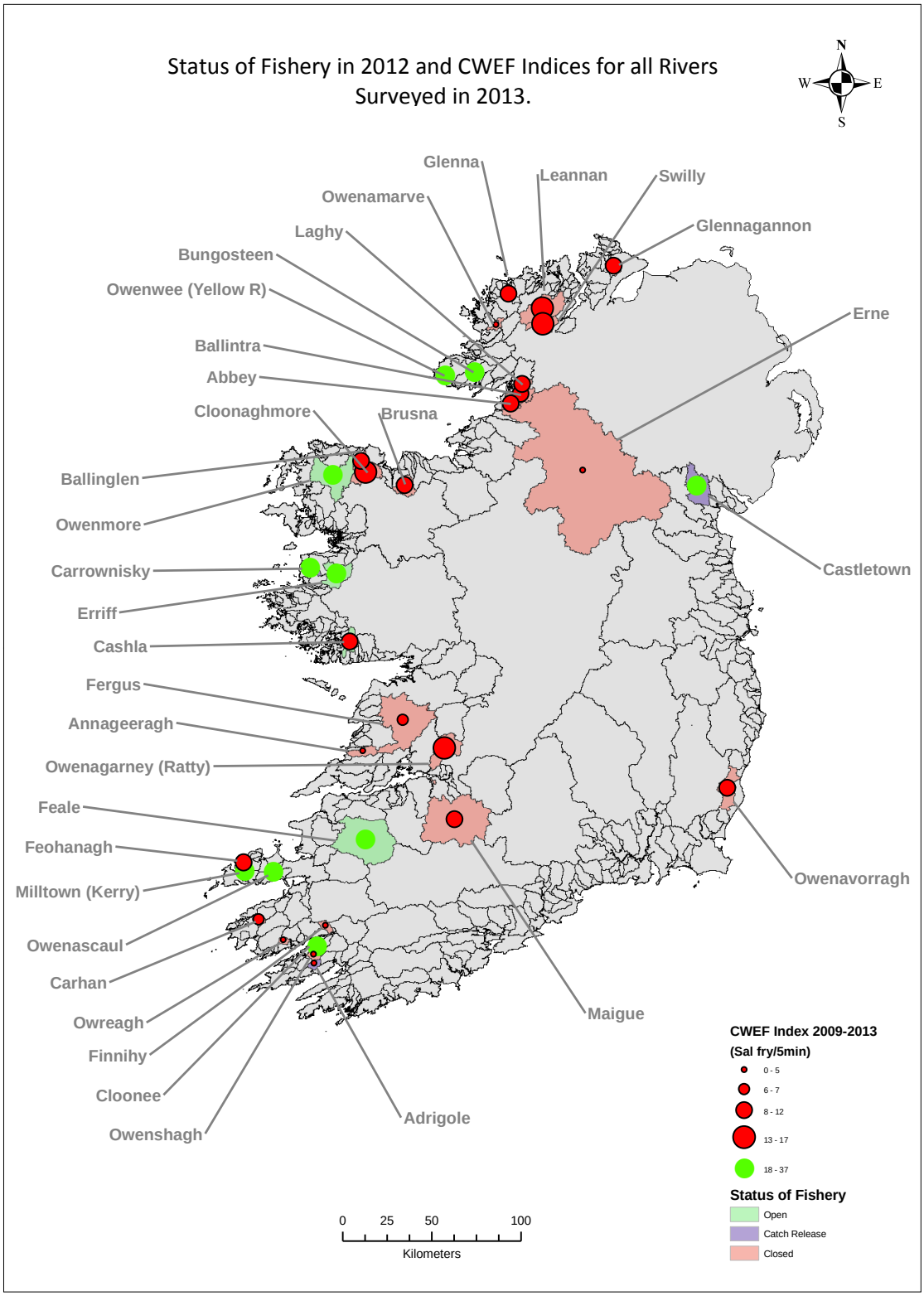


Figure 3.2.2: Summary of CWEF Indices for the Catchments Surveyed in 2013.

IFI Code /River	2009		2010		2011		2012		2013		Total # Sites	CWEF Index (2013)
	# Sites	Avg	# Sites	Avg	# Sites	Avg	# Sites	Avg	# Sites	Avg		
Neagh Bann IRDB											0	
003/Castletown	8	26.41							11	22.96	19	24.68
South Eastern RDB											0	
028/Owenavorragh			7	19.76					6	0.33	13	10.04
South Western RBD											0	
081/Adrigole									7	4.01	7	4.01
085/Owenshagh									11	4.32	11	4.32
086/Cloonee							6	16.18	6	33.06	12	24.62
089/Finnihy							6	8.61	6	0.00	12	4.31
093/Owreagh									6	2.07	6	2.07
101/Carhan									8	6.05	8	6.05
109/Owenascaul	10	22.27							10	16.08	20	19.18
111/Milltown (Kerry)			7	26.44					8	13.02	15	19.73
Shannon IRBD											0	
112/Feohanagh	10	16.61							10	3.20	20	9.91
119/Feale									63	23.56	63	23.56
126/Maigue	50	2.82	59	16.05					60	12.05	169	10.31
130/Owenagarney (Ratty)									15	16.97	15	16.97
131/Fergus	29	4.10	32	6.84					45	5.63	106	5.52
135/Annageeragh									12	1.82	12	1.82
Western RBD											0	
152/Cashla									33	10.83	33	10.83
168/Erriff	33	16.03	46	20.43	32	20.86	25	27.40	33	27.45	169	22.43
171/Carrownisky							19	20.60	17	18.22	36	19.41
186/Owenmore - MC Muinhin (Bangor)									55	27.00	55	27.00
193/Ballinglen					12	15.09			10	6.37	22	10.73
194/Cloonaghmore (Palmerstown)			33	9.71	27	22.27	33	17.32	28	15.02	121	16.08
196/Brusna	34	4.70							30	14.16	64	9.43
North Western RBD											0	
210/Erne	22	0.17	53	0.29	17	0.06	62	0.00	31	0.00	185	0.10
211/Abbey									2	7.20	2	7.20
212/Ballintra	3	10.27							16	13.40	19	11.83
213/Laghy	9	8.58							11	14.97	20	11.77
217/Bungosteen					10	25.12			9	17.09	19	21.11
220/Owenwee (Yellow R)	8	14.81					4	20.31	15	19.65	27	18.26
226/Owenamarve	6	3.76							7	2.64	13	3.20
234/Glenna	6	16.80			6	3.77			6	7.77	18	9.45
248/Leannan	29	8.73	29	16.71	28	12.36	28	21.51	26	19.51	140	15.76
249/Swilly	17	7.36							14	18.08	31	12.72
259/Glennagannon	10	16.65			11	4.05			11	7.13	32	9.28

Table 3.2.1: Summary of Catchments sampled during 2013.



Map 3.2.1: Catchment-wide electrofishing results for catchments surveyed in 2013 along with their status during the 2013 angling season.

2.3. Results 2007 – 2013

Update for 2013

Over the 2007 to 2013 period, a total of 5745 site surveys have been carried out in 274 catchment surveys on 130 separate catchments nationally. CWEF indices presented in this report are based on data not more than five years old. For this reason data collected prior to 2009 is not presented in this report. The overall catchment index is a mean of the values obtained over the survey years.

For results 2009 to 2013 see appendix C.

Trends in Salmon Fry Abundance Over Time

Data in Fig 3.3.1 presents the catchment-wide electro-fishing mean abundances of salmon fry in 48 catchments where more than one year's electro-fishing results are available; Figure 3.3.2 Shows the current average salmon index for all catchments surveyed to date. Sixty-one catchments have only one survey within the 5 year period used to calculate the CWEF index.

High mean salmon fry abundance was recorded each year on the Castletown, Glyde, Dee, Boyne, Liffey Lower, Slaney, Cloonee, Owenascaul, Carrownisky, Erriff, Garvogue, Duff, Eany, Bungosteen, Lackagh and Leannan. A decrease in salmon fry abundance was observed on the Finnihy, Emlagh, Feohanagh, Ballinglen, Glenna and Glennagannon Glenna rivers. An increase in salmon fry abundance was observed on the Fane, Liffey Upper, Dargle, Barrow, Owenwee (Yellow) and Erriff rivers; a more detailed assessment of trends in salmon fry abundance by Fishery Region is provided in Appendix A.

A catchment-wide salmon fry average for rivers electro-fished from 2009 to 2013 is presented (Map 3.3.1.) Generally, rivers fished along the east and south east coast recorded low salmon fry abundance. Low abundance was also recorded for rivers in the north-west and Donegal bay. Highest salmon fry densities were recorded in rivers in Kerry and Connemara.

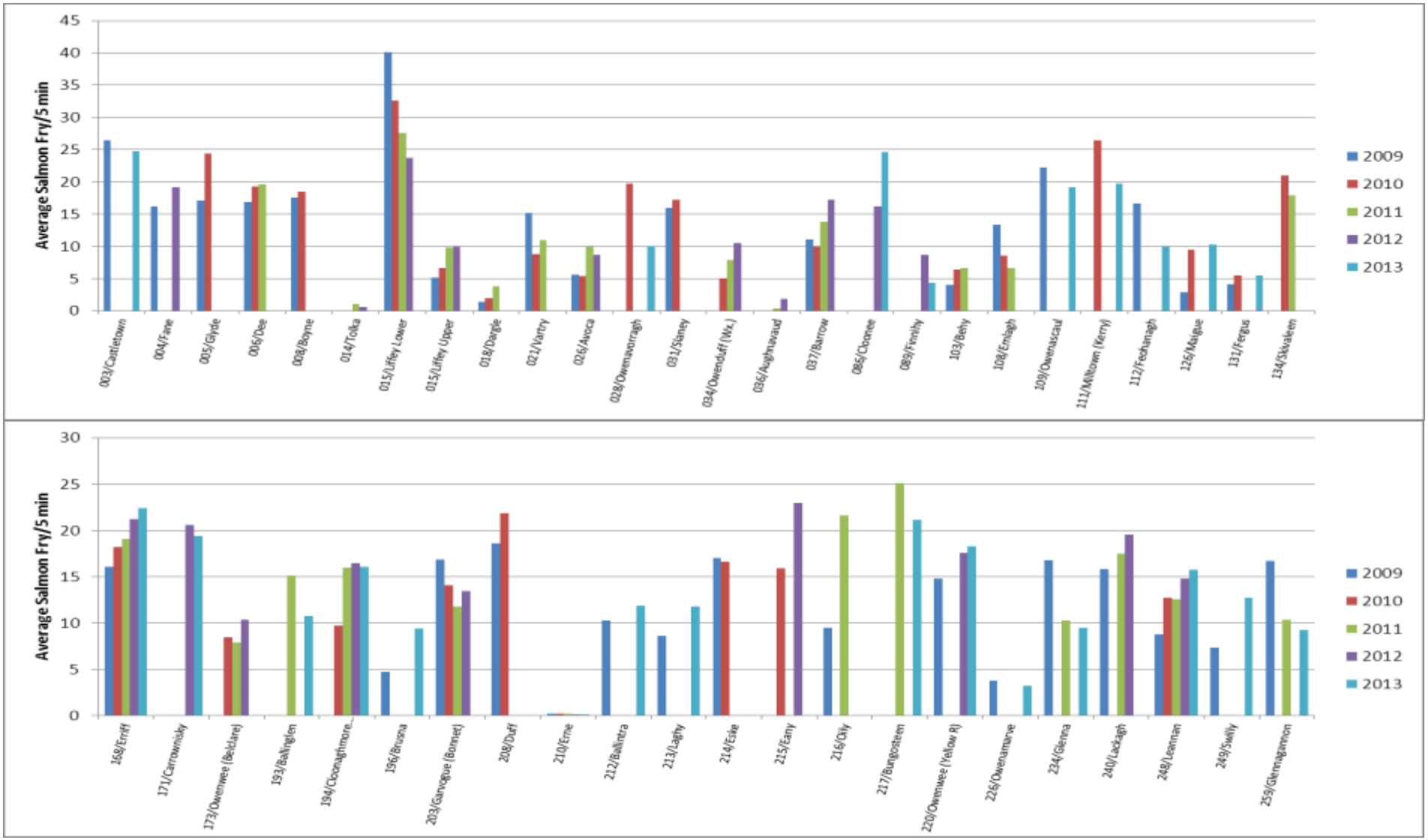


Fig 3.3.1: Annual Catchment-Wide Electrofishing results for Catchments with current CWEF indices that have been sampled more than once between 2009 and 2013.

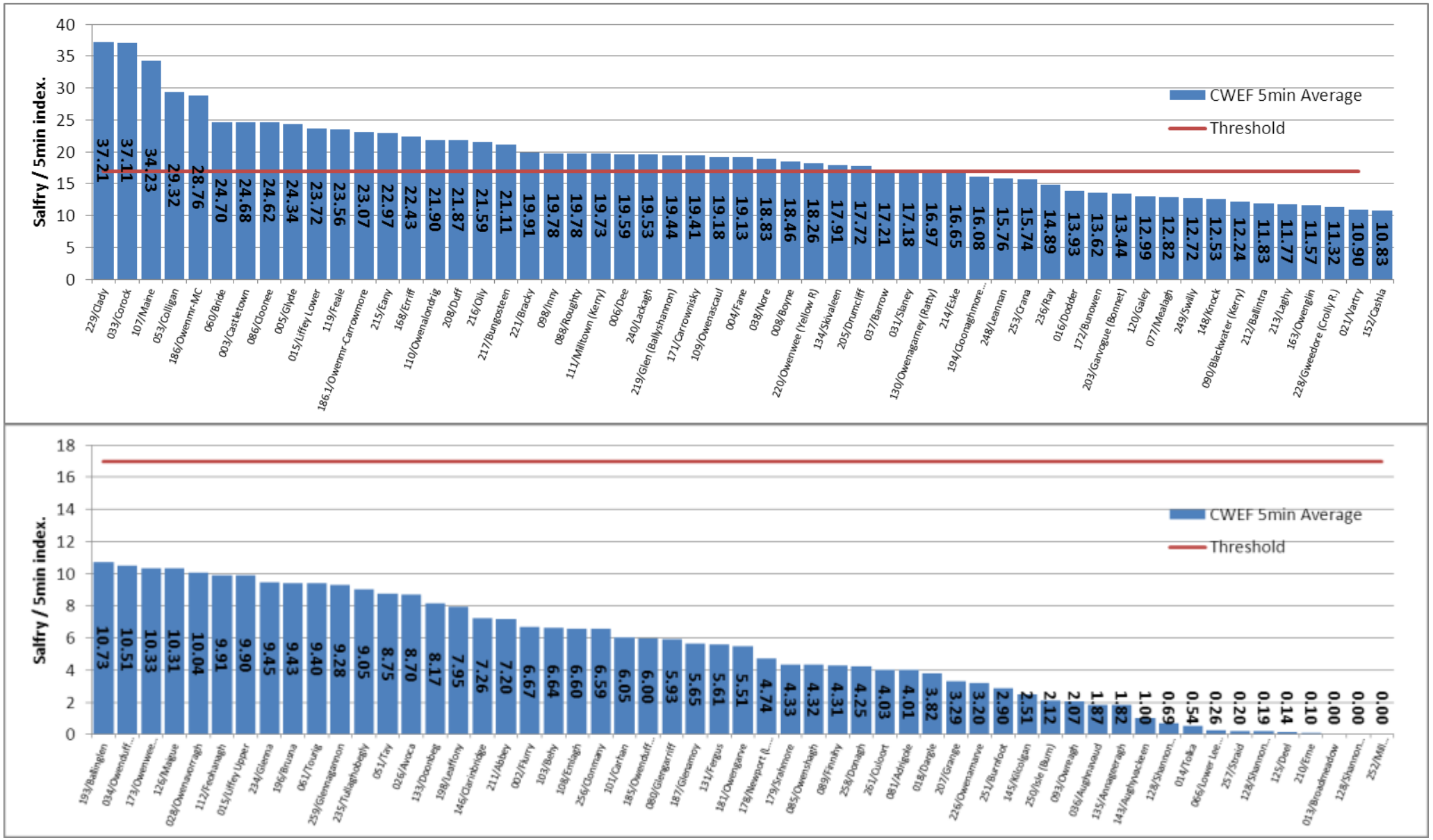
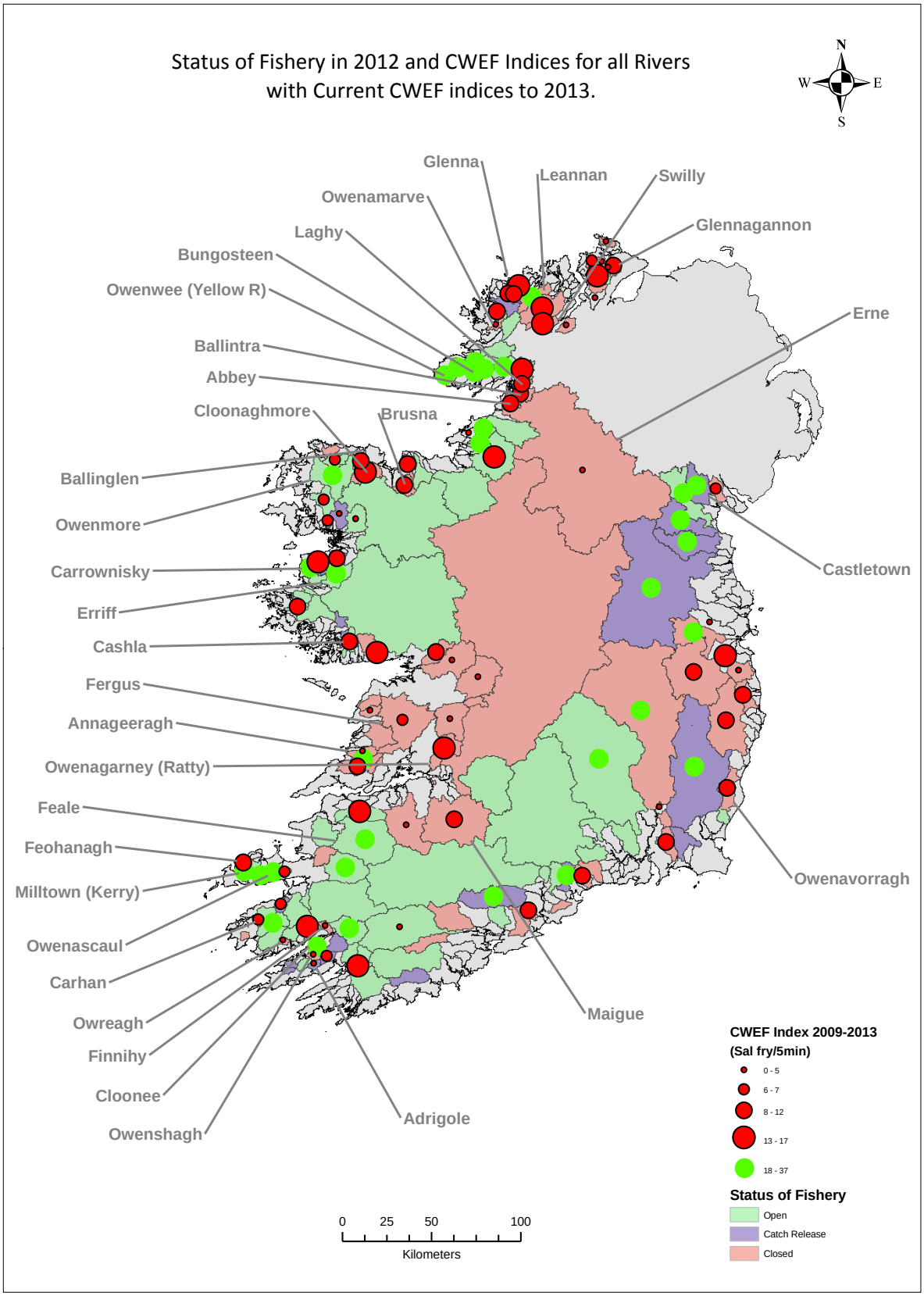


Fig3.3.2: Mean Catchment-wide electrofishing results for all catchments with Current CWEF Indices to 2013

.



Map 3.3.1: Mean Salmon Fry indices for all catchments with current CWEF Indices up to 2013 along with the status of all catchments during the 2012 fishing season.

3. Development of a raising factor for upstream counts at partial fish counters

Several existing fish counters are partial counters, i.e. they cover a portion of the river and only count a proportion of the adult salmon run. Examples include the Slaney, Blackwater, Bandon, Corrib, and Moy where counters are usually located at the head of fish passes or traps. The recorded count on each of these rivers has to be raised by a factor to provide an estimate of the total upstream run. A telemetry based project, using PIT tag technology, was undertaken in 2008 on the River Corrib to improve the accuracy of the raising factor applied to this count. The project was designed to assess the feasibility of using the technology for assessing the efficiency of all partial counters. The Corrib project provided a raising factor based on high quality PIT tag data which supported the further roll-out of this technology for future projects.

The basis for these site specific Passive Integrated Transponder (PIT) tag studies is a variation of a mark-recapture exercise. Adult salmon are tagged with an individual PIT tag (Passive Integrated Transponder tags); these are small uniquely coded microchips (about the size of a grain of rice). A tag is mounted on a floy tag and this floy tag/PIT tag assembly is attached to the salmon just under the dorsal fin using a hand-held applicator gun. A PIT tag scanner (antenna) is permanently positioned in or close to the fish counter and the scanner will read the electromagnetic code of the tag after a tagged salmon has passed through the counter. A de-coder stores the tag number and the date and time of this event. In its simplest application, in single channel counters, by determining the number of pit-tagged salmon passing through the counter relative to the total number of fish pit tagged, it is possible to determine, for the prevailing conditions, the total upstream run. To increase knowledge of upstream migrations related to local conditions pit tagging needs to be undertaken over a range of water heights as the usage of a fish pass and counter may change with changing river flow conditions. Results from the Corrib study have demonstrated that the technique has the ability to more accurately estimate total salmon runs at partial salmon count sites. Where the counter utilises multiple channels (i.e. the Boyne counter) the analysis is more complex.

The Boyne PIT tagging study outlined in this report is year 4 of a five year programme and was complemented by radio tagging of some of the PIT tagged fish. Radio tagging provided data on the proportions of all PIT tagged fish that migrated to the fish counting facility at Blackcastle and a more accurate estimation of the numbers of salmon available to ascend through the multiple counter channels at the counting site.

3.1. River Boyne.

PIT tagging on the Boyne 2013

Sampling of adult salmon was undertaken, using a traditional draft net, by Boyne draftnet fishermen, under the daily supervision of Eastern RBD staff, based in Drogheda, from June 18 – August 2, 2013. A total of 222 salmon were PIT tagged at the draft net sampling station in the Boyne estuary at Mornington. Of the total, 53 (23.9%) were tagged in June with the majority 140 (63%) being tagged in July and 29 (13.1%) in August. The estimated mean weight for PIT fish was 4.38 kg (range 0.91-9.06) (Fig 3.1). One PIT tagged salmon passed through the PIT tag antennae at Blackcastle in 2013. This fish had been tagged in 2012.

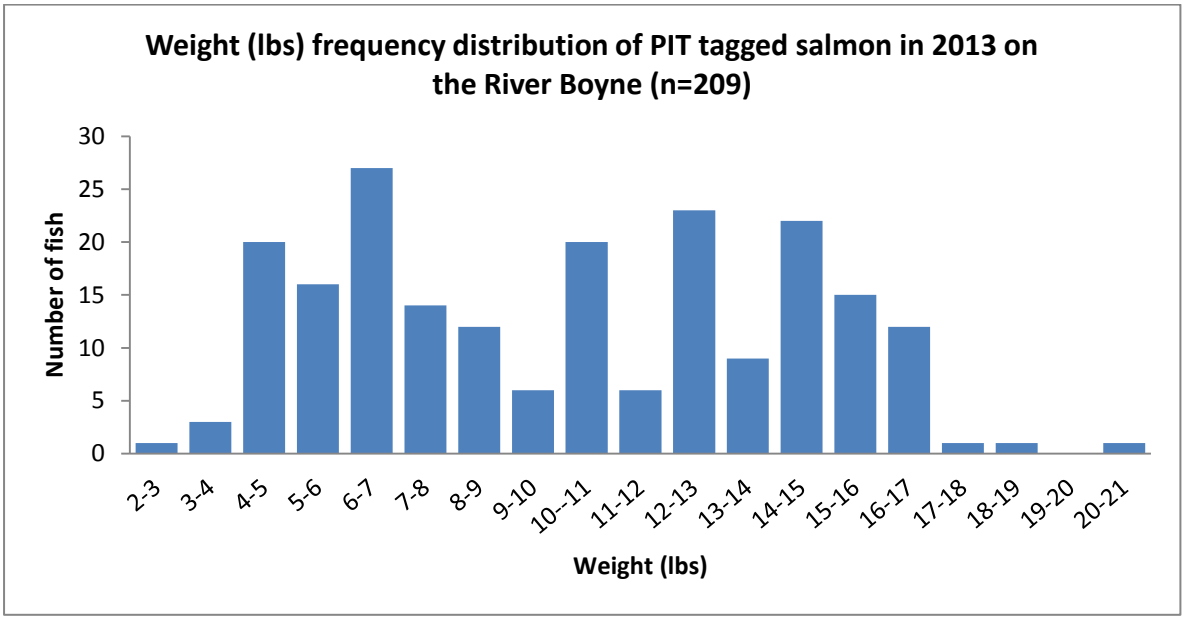
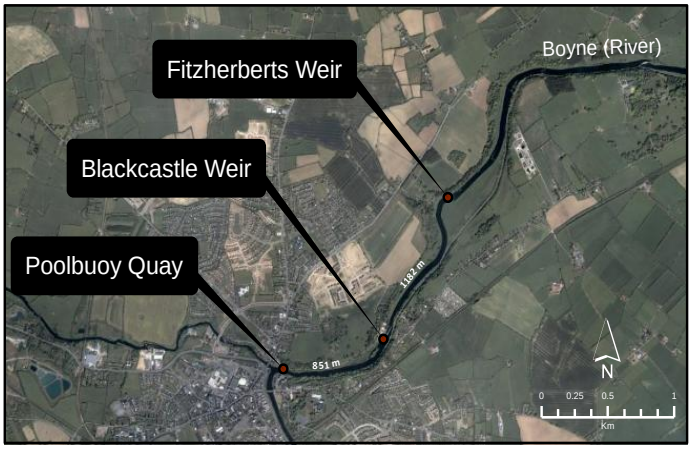


Figure 3.1. Weight frequency distribution of PIT tagged adult salmon on the River Boyne estuary

Radio tagging on the Boyne 2013

Four ATS radio receiver/dataloggers were installed at fixed locations along the Boyne in 2013. The receivers automatically detect radio tagged fish within their scanning range and store date and time of detection. Three locations, Fitzherberts weir, Blackcastle weir and Poolbuoy are close to Navan town, and these locations were selected to provide migration data to quantify the escapement of salmon over the weir at Blackcastle. The other receiver was situated at the Curly Hole/ Marry's to detect fish that ascended into freshwater near the tidal/freshwater interface and provide an estimate of the numbers /frequency and timing of salmon entering freshwater.



Map 4.0.1: Location of Radio receivers on the Boyne. Pit tag detectors are present at Blackcastle weir.

In 2013 a total of 30 salmon were radio tagged (Table 3.1). Tagging was carried on various dates between 17 July and 2 August at the sampling station. The majority (22 fish) was tagged over the final four days of sampling period. The average weight of radio tagged fish was 3.75 kg although fish of various weights were tagged over the period.

Table 3.1. Radio tagged salmon: tagging date and average, min & max weight (kg)

Date	No. tagged	Average weight (kg)	Min (kg)	Max (kg)
17/07/2013	2	5.45	4.54	6.36
19/07/2013	2	7.26	7.26	7.26
23/07/2013	2	2.50	1.82	3.18
25/07/2013	2	2.72	2.72	2.72
30/07/2013	6	3.18	1.82	4.54
31/07/2013	5	3.81	2.72	6.36
01/08/2013	5	4.31	2.72	7.26
02/08/2013	6	2.80	1.82	4.54
Grand Total	30	3.75		

Movement of radio tagged salmon was limited following tagging due to low water levels (Fig. 3.2) which were a feature of the River Boyne in 2013. From April to mid-October 2013 water levels were exceptionally low and contrast significantly with water levels from the previous year (Fig. 3.2). The normal water level pattern is episodic flood events throughout the year including the summer period. In total 20 fish had been recorded at Marry's by October but by mid -October only one had ascended the weir at Blackcastle and been recorded upstream at Poolboy (Navan). The fate of the unrecorded fish is unknown. A detailed analysis of the data from 2010 – 2013 is on-going and the fate of individual fish, in respect of associated radio and PIT tag data, will be used to drive development of a model for the revised raising factor which will provide a more robust basis to raise the overall count at Blackcastle.

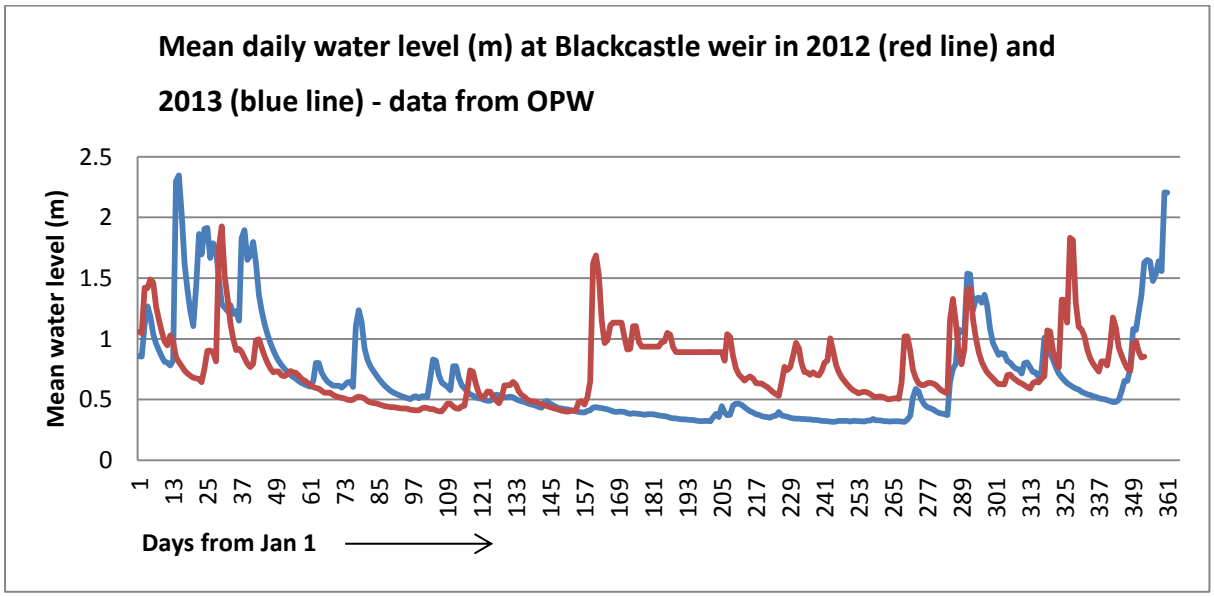


Fig. 3.2. Water levels at Blackcastle weir (River Boyne) in 2012 and 2103.

4. Biological Assessment of Salmon Populations

Knowledge of salmon life history strategies is required to understand and model salmon populations in different systems. Biological data on salmon populations including sea age, run-timing, sex ratio and fecundity are necessary to understand population dynamics within a river. Changes to any of these inputs can influence the outcome of the production models used to predict the likely returns to a river and potential fishery performance. Life history traits such as smolt age, sea age, growth and frequency of spawning can be determined from scale readings. Combined with data on time of entry into the system, sex ratio and fecundity, which can be collected from any killed fish, the often complex make up of a population can be established and the models can be adjusted accordingly. For example, if the proportion of Multi-Sea-Winter (MSW) salmon entering a system is greater than previously known this would have the effect of reducing the CL as these fish are likely to have a higher female:male ratio and would transport a greater number of eggs into a catchment because of their greater size compared to grilse.

In order to enhance the quality of the existing models and to improve the quality of the scientific advice, particularly for rivers where the stock structure is complicated (e.g. river has significant spring salmon and a grilse component or other stock components) or has changed, it is important to obtain data on the stock. Run-timing of the different components may influence harvesting options. Figure 5.1 shows the proportions of fish of different lifestyles changing throughout the year. Sex ratio and fecundity may change in response to the composition of the total population. These data are required for the on-going scientific assessment of salmon fisheries in which IFI is intimately involved through the machinations of the Standing Scientific Committee.

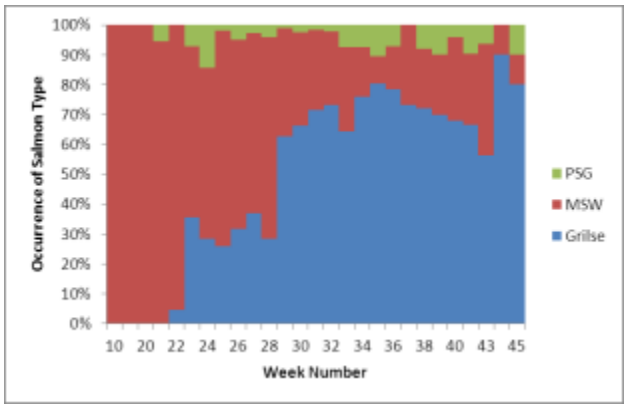


Figure 5.1: Occurrence of Salmon of each life history type each week compiled from samples collected from Boyne, Nore, Castlemaine, Suir, Ballinahinch, Blackwater, Sneem, Feale, Owenmore and Foyle, 2007 to 2013. (MSW=Multi-Sea Winter, PSG=Previously Spawned Grilse).

4.1. Salmon Life

Salmon scales were collected from commercial fisheries over the course of the project's current monitoring period 2007-2013. The commercial fishery operates over a defined period during the summer at each location allowing for direct comparison of age and stock structure. Some examples of outputs from the analyses are presented below.

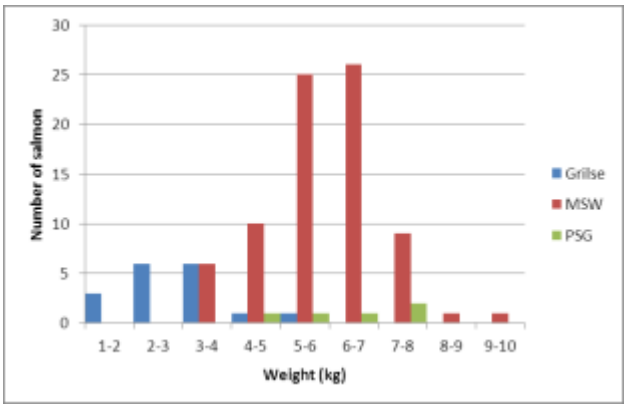


Figure 5.2: Weight distribution of Salmon of various life histories. From the Boyne 2013. N=102.

Salmon scales were collected and analysed from the scientific draft net fishery on the Boyne between June 18th and Sept 7th 2013. 102 fish were sampled; all of these scales were examined. Of the 102 fish, 80 of fish were Multi-sea winter fish (MSW), just 17 were grilse; the remaining 5 fish were previously spawned grilse (PSG). Of these three fish types the PSG were on

average the largest, with a mean weight of 6.2 kg, MSW had an average weight of 5.7kg and grilse an average weight of 3kg. It can be seen on figure 5.2 that most of the grilse were below 4kg and all MSW and PSG were 4kg or above.

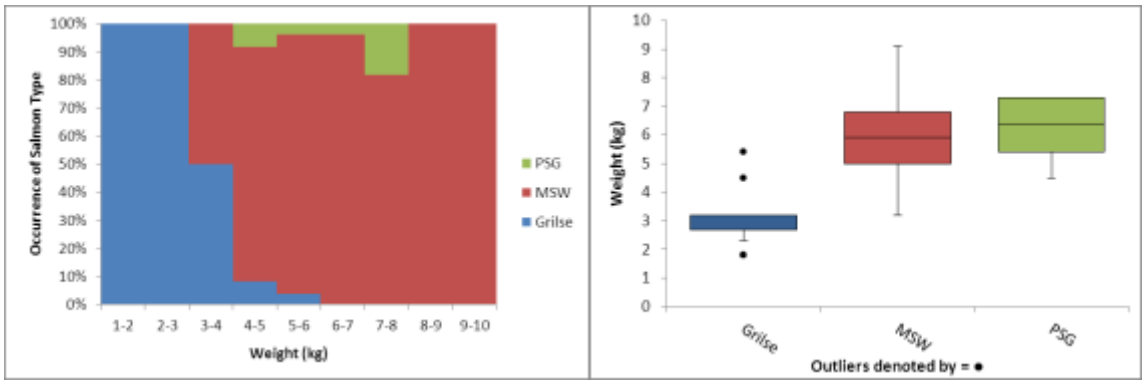


Figure 5.3: Left: Occurrence of fish life history by weight (kg)..Right: Boxplots of weights (kg) of individual fish of different life history types. (N=102, Data from Boyne fish 2013)

4.2.Comparison of Boyne Salmon life histories with other catchments.

The proportion of fish of various life histories in various catchments has been determined by scale reading over several years. The proportion of fish of various life histories varies greatly between catchments. Those on the west coast have a higher proportion of grilse than fisheries on the south and east coast. On the Boyne a very low proportion of the fish captured were grilse.

River/ Year	Grilse	MSW	PSG	# Fish Read
Owenmore 2006	94%	6%	0%	17
Ballinahinch 2008	89%	11%	0%	18
Feale 2006	87%	13%	0%	15
Ballinahinch 2009	86%	14%	0%	14
Waterford 2008	86%	7%	7%	14
Ballinahinch 2007	85%	15%	0%	13
Waterford 2010	79%	15%	6%	292
Castlemaine 2010	66%	25%	9%	163
Blackwater (Munster) 2011	61%	36%	3%	66
Blackwater (Munster) 2012	59%	38%	2%	130
Sneem 2011	53%	47%	0%	17
Suir 2011	46%	49%	5%	111
Nore 2011	40%	59%	1%	143
Nore 2009	33%	42%	26%	43
Nore 2010	32%	55%	13%	78
Boyne 2013	17%	78%	5%	102

Table 5.1: Showing the percentage occurrence of Salmon of various life histories as revealed by scale reading. Only locations and years where more than 10 scales were read are included.

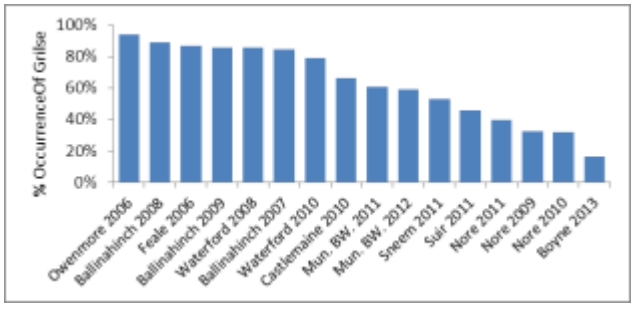
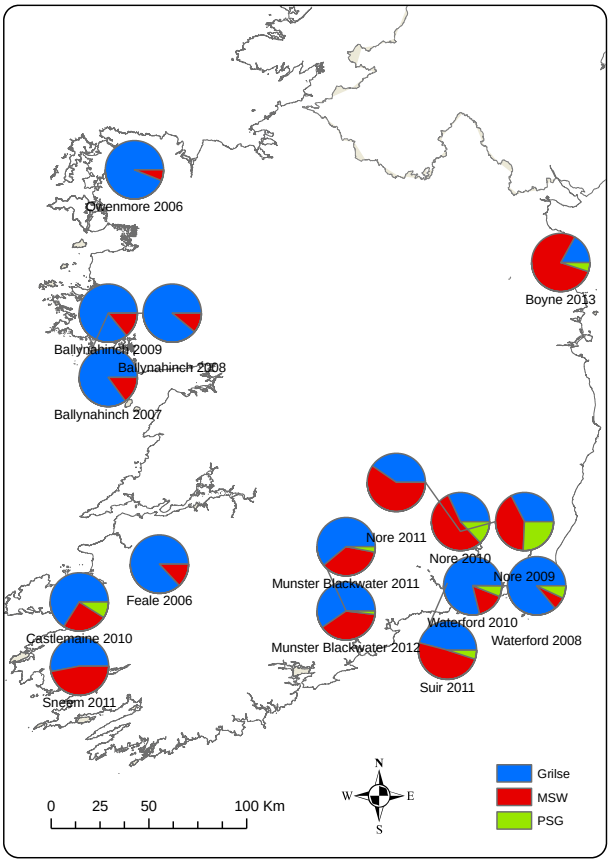


Figure 5.4: Showing the percentage occurrence of Salmon of various types as revealed by scale reading. Only locations and years where more than 10 scales were read are included.



Map 5.1. Displaying the proportions of salmon of different life histories at the general locations of different fishing locations in different years.

Analysis of Fry Age at length on the Cashla

During the CWEF survey on the Cashla between the 3rd and the 30th of July 453 juvenile salmon were encountered. 53 sets of juvenile scales were read. (Figure 5.5) All fry < 8.4cm forklength were 0+, and all fry > 12.6cm were 2+.

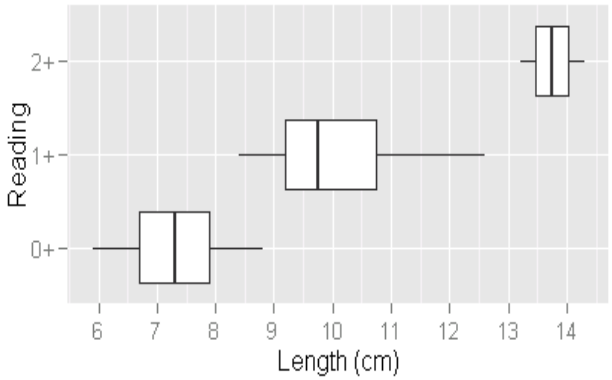


Figure 5.5 Boxplot showing lengths of age classes in the subsample of 53 Salmon.

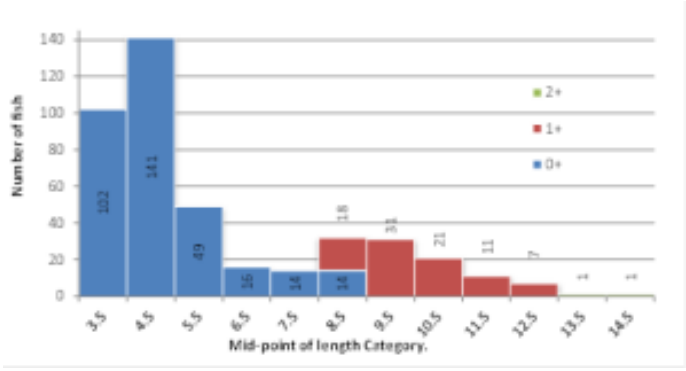


Figure 5.6: Length distribution of Salmon captured in 2013 CWEF Survey on the Cashla River categorised by expected age. n=426

References

Amiro, P.G. Habitat measurement and population estimation of juvenile Atlantic salmon (Salmon salar), P.81-97. In R.J. Gibson & R.E. Cutting (ed.) Production of juvenile Atlantic salmon (Salmon salar) in natural waters. Can. Spec.Publ.Fish.Aquat.Sci.118

Anon (2009) Report of the Standing Scientific Committee of the National Salmon Commission; The status of Irish Salmon Stocks in 2008 and Precautionary Catch advice for 2009.

Anon (2007) Report of the Standing Scientific Committee of the National Salmon Commission; The Status of Irish Salmon stocks in 2007 and Precautionary Catch advice for 2008.

Cowx IG & Fraser D (2003). Monitoring the Atlantic salmon. Conserving Natura 2000 Rivers Monitoring Series No.7 &, English nature, Peterborough.

Crozier, W.W. & Kennedy, G.J.A. (1994) Application of semi-quantitative electrofishing to juvenile salmonid stock surveys. Journal of Fish Biology (1994) 45, 159-164

McGinnity, P. Gargan, P. Roche, W., Mills, P. & McGarrigle, M. (2003) Quantification of the freshwater salmon habitat asset in Ireland using data interpreted in a G.I.S. platform. Irish Freshwater Ecology & Management Series: No.3, Central fisheries board.

McGinnity P., DeEyto, E., Gilbey, J., Gargan, P., Roche, W., Stafford, T., McGarrigle, M., O'Maoileidigh, N., & Mills, P. (2012). A predictive model for estimating river habitat area using GIS-derived catchment and river variables. Fisheries Management and Ecology, 19 (1) 67-77.

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Wickham, H. (2009) ggplot2: elegant graphics for data analysis. Springer New York, 2009.