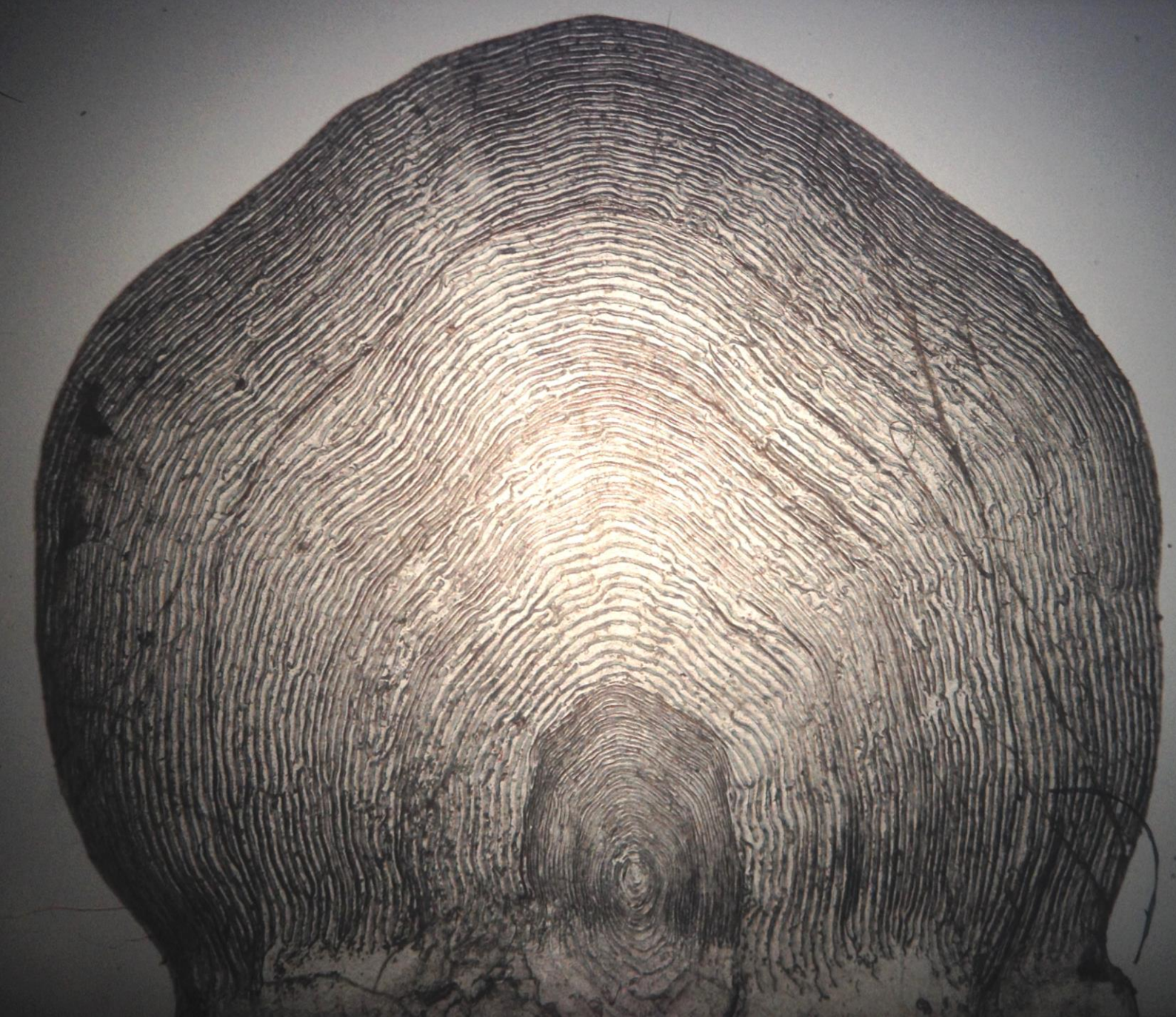

Ness and Beauly Fisheries Trust

Review of 2015 to 2018 Adult Salmon Scale Sampling Programme in the Beauly system

Version 1.2

Ness & Beauly Fisheries Trust

DOCUMENT CONTROL

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Chris Conroy (Director, NNBFT)	**04/04/2019**	
File Reference	**Revision**	**Notes**
C:\Users\NDSFB\Documents\Documents\ScaleReading\Beauly	**v1.2**	

A document prepared by the Ness & Beauly Fisheries Trust, presenting the results of our 2015 to 2018 Scale Sampling Programme in the Beauly system.

The cover image shows a scale from a 16lb fresh run 'spring' salmon aged 3.2 years.

Particular thanks to the following individuals for their assistance in the coordination and collection of scale samples:

- Beauly angling club members.
- Willie Matheson (Head Ghillie)
- Frank Spencer-Nairn (River Farrar)

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EXECUTIVE SUMMARY

- Scale samples were submitted from a total of 232 adult salmon captured between 2015 and 2018, equating to 12.28 per cent of the total salmon catch for the period (1,890 fish).
- Sampling effort was low in March and the river Glass was largely underrepresented in the reported scale samples.
- Sampling effort varied substantially across the years but in most cases the reported scale samples seem to be correlated with the number of rod catches.
- It was possible to determine the freshwater age for 217 of the scale samples submitted between 2015 and 2018. The majority of these fish (69.1 per cent) were found to have spent two years in freshwater before migrating to the sea.
- No previous spawners were caught in the Beauly system over the 5 years period.
- It was possible to determine the freshwater age for 217 of the scale samples submitted between 2015 and 2018. The majority of these fish (69.1 per cent) were found to have spent two years in freshwater before migrating to the sea. A further 31.3 per cent were found to have spent three years in fresh water.
- Scale readings indicate that a large number of grilse sampled between 2015 and 2018 (44.2% per cent) have spent two years in freshwater as juveniles. Multi-sea-winter adults were more likely to spent two years in freshwater (24.9%). Low proportion of multi-sea-winter salmon was originated from the 3-year-old juveniles (6.5%).
- With 72.8 % of the sample catch, Grilse was the most representative group on the collected salmon scales in the Beauly system followed by 2 years at sea MSW (31.8%) and 3 years at sea MSW fish (0.9%).
- The MSW salmon were found to range between four and six years of age. The majority were found to have a total age of four years (77.9 per cent), followed by those with a total age of five years (20.6% per cent) and a further 1.5% at six years of age.
- Analysis of scale samples taken from fish caught in the Beauly system from 2015 to 2018 resemble the typical upstream run of salmon to freshwater in which a large proportion of the multi-sea-winter fish are being recorded early in the season (months March to June) with Grilse being recorded later (from June onwards). There existed significant weight differences between fish with plus growth (generally less than 7 lbs) and fish with no plus growth or “spring salmon” (generally more than 7 lbs)
- The majority of the sample catch in April was dominated by no plus growth fish or “Spring salmon”. Furthermore, no plus growth fish were also recorded in lower proportions in May (35.7%), June (13.6%) and July (2.1%). On the other hand, there exists evidence of plus growth fish in each of the sample months ranging from 16.7 % in April to dominate all the sampled catch by July/August.

- The scale samples taken from fish caught in the Beauly system from 2015 to 2018 resemble the typical upstream run of adult salmon to freshwater in which a large proportion of the multi-sea-winter fish are being recorded early in the season (months March to June) with Grilse being recorded later (from June onwards). The presence of 3 Year MSW fish was low and restricted to the months of April and May.

- The majority of the sample catch in April was dominated by no plus growth fish or "Spring salmon". Furthermore, no plus growth fish were also recorded in lower proportions in May (35.7%), June (13.6%) and July (2.1%). On the other hand, there exists evidence of plus growth fish in each of the sample months ranging from 16.7 % in April to dominate all the sampled catch by July/August.

- The results indicate that the months of April and May are particularly important for spring salmon on the Beauly system. This suggests that The Scottish Government's statutory conservation measures for 'spring' fish (all fish must be returned up to the 1st April), although welcomed, do not go far enough.

- Fish in the sample aged as grilse (1SW) were found to range between 1.5 and 10 pounds in weight, with an average weight of 4.6 pounds. The 2SW salmon ranged from 6 to 15 pounds, with an average weight of 10.2 pounds. The only reported weight for a 3SW salmon was 16 pounds. If we assume that these samples are representative of the wider salmon population in the Beauly system, then the results suggest that fish over 9 pounds are most likely to be MSW salmon, with fish under 5 pounds most likely being 1SW grilse. Fish between 5 and 10 pounds could be either MSW salmon or grilse and difficult to positively identify without scale reading.

- Overall, females were found to account for 56.8% per cent of the total sample. Further, similar percentages of females and males where found across the grilse and MSW groups. This finding is surprising because generally a greater proportion of MSW than grilse are known to be female. However, given the difficulties assessing the sex of the fish it is premature to draw any firm conclusions based on this result advocating more research.

- It is recommended that both length and weight data be collected during scale sampling so that it can be used to develop a 'Beauly Specific' Length/weight conversion chart.

Contents

1 INTRODUCTION

The collection and ageing of Atlantic salmon scales has become a fundamental fisheries management tool. It allows determination of river age, sea age and various other scale characteristics for stock discrimination (Shearer, 1992). Growth patterns can be related to production, environmental trends. Timing of physiological changes such as maturation, smoltification and spawning can also be identified. This information, combined with sex and size data, can be used to inform management decisions within a fishery.

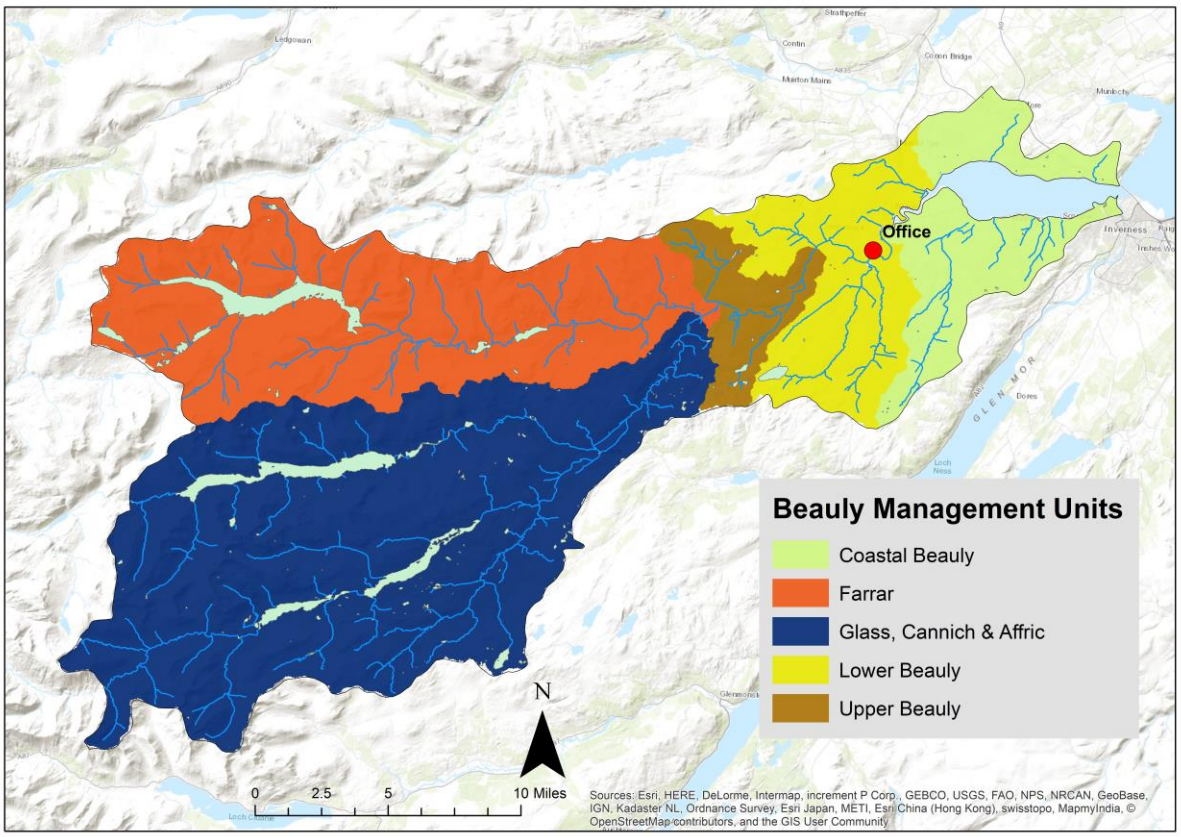
This report provides an overview of the Beauly 2015 to 2018 Scale Sampling Programme. This starts with a description of the basic markings and structure of fish scales, scale ageing techniques and the sampling procedures employed. It goes on to present the results of the programme; including the numbers and quality of scale samples submitted over the five-year period and analysis of the resulting data in terms of age composition and run timing. Finally, the report looks at practical management applications of the scale ageing data and makes recommendations for future years.

2 THE BEAULY SYSTEM

The River Beauly drains a catchment of approximately 1000 square kilometers of land. The catchment extends almost to the west coast with the most westerly tributaries being only approximately 7km east of Loch Duich. For management purposes the district can be sub-divided into five management units. The management units utilised for the Beauly Fisheries Management Plan are:

- Coastal Beauly
- Farrar
- Glass, Cannich & Affric
- Lower Beauly
- Upper Beauly

Figure 2.1 - Beauly System Fishery Management Units



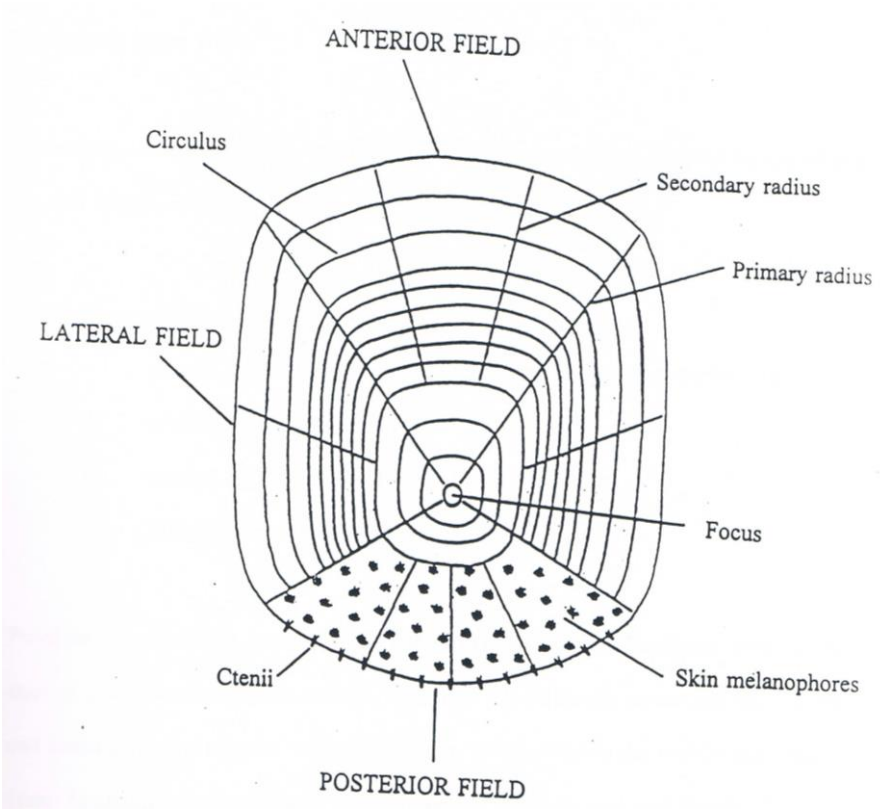
3 PRINCIPLES OF SCALE READING

Many of the skeletal structures of fish such as scales, otoliths, opercular bones and fin rays exhibit growth rings. These rings are formed annually due to seasonal fluctuations in growth and so can be used to give an indication of the age of a fish. Scales are usually the chosen structure because they can be sampled without sacrificing the fish.

3.1 BASIC MARKINGS AND STRUCTURE

The basic markings and structure of a typical generic fish scale are shown in **Figure 3.1**. It can be seen that bands of individual lines known as 'circuli' radiate out from the centre of the scale, the 'Focus'.

Figure 3.1 - Basic markings and structure of a generalised fish scale



When the scales are attached to the fish they are held in pockets. The circuli are formed as the scale pushes against the dermis and the pressure forms ridges on the scale which then become calcified. This process occurs at the edge of the scale where the new growth is soft. As the circuli age and become further away from the edge of the scale, they harden as they become impregnated with mineral salts.

During the summer months, when food availability is high, the fish grows quickly. In the colder months growth slows down or stops and the circuli form closer together leaving incomplete ridges. When the fish begins to grow again in the warmer months a new ridge is formed which 'cuts across' the incomplete circuli, this region is known as an annual 'check' or 'annuli'.

The annuli in different species or specimens may differ in appearance, but will always have one or more of the following characteristics:

- Cutting over of circuli;
- Closely spaced circuli followed by a zone of widely spaced circuli;
- Abrupt ending of circuli;
- Uneven spacing of circuli; and
- Clear patches without any circuli.

The age of the fish can be determined from the number of annual checks (annuli). Temperature is the main contributing factor to annuli formation, due to its effects on the metabolic rate and growth of the fish.

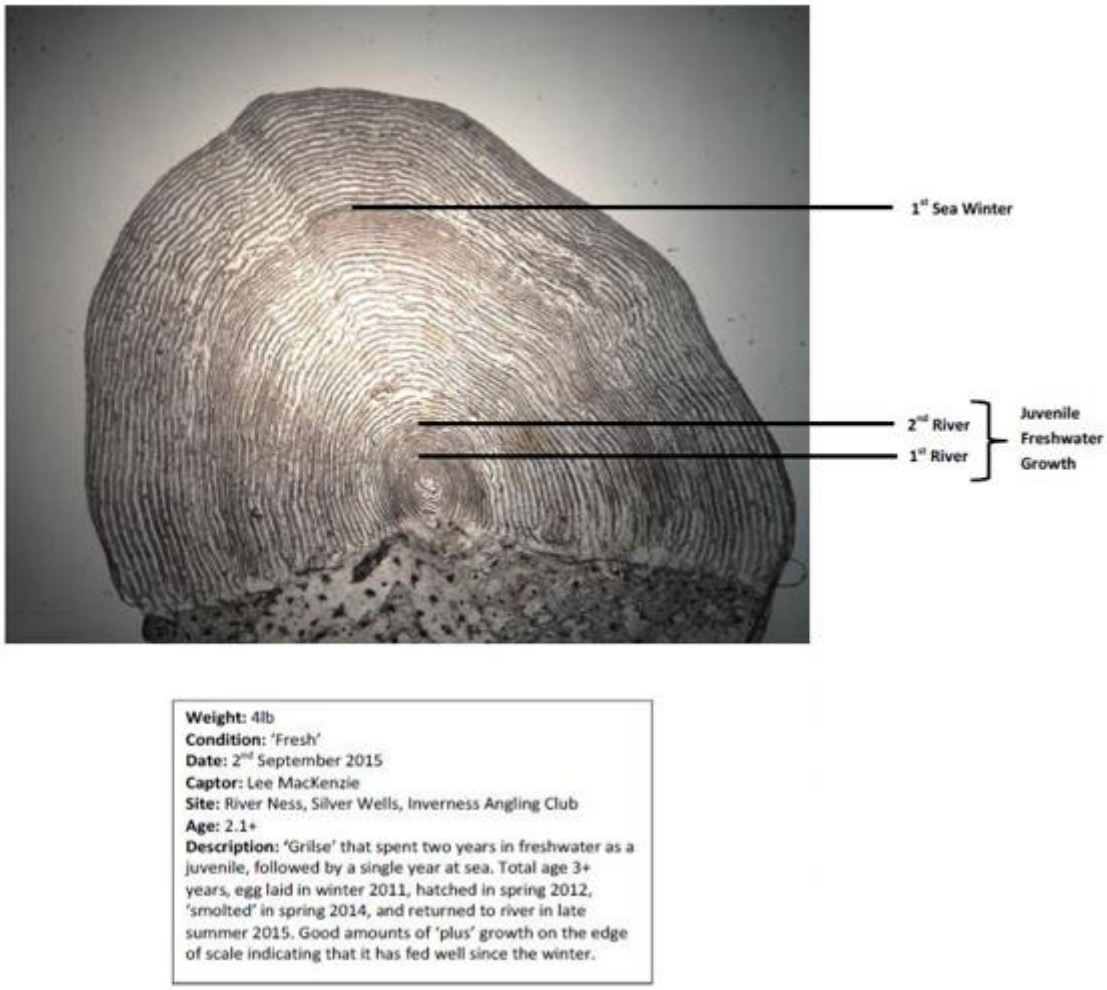
False checks are a common feature on scales, particularly where the growth of the fish has been interrupted by factors such as pollution events, capture by anglers or sudden changes in temperature. This makes the ageing of fish more difficult, especially in cold water species such as salmon and trout. These are very sensitive to extremes of temperature and may stop feeding in very warm or very cold conditions.

3.2 SALMON SCALES

Salmon are 'anadromous' (fish which migrate up rivers from the sea to spawn) and so their scales exhibit features from their freshwater and seawater years. After hatching, the salmon spends on average two years in freshwater where it is known as a 'parr'. The salmon then undergoes 'smoltification' and migrates downstream towards the sea for the first time, marking the end of freshwater growth.

The fish stays at sea for at least one winter where its scales exhibit large growth rates due to the abundance of food available. If they first return after one sea winter, they become known as grilse. An image of a typical grilse scale is presented in **Figure 3.2** below.

Figure 3.2 - Scale from a grilse aged 2.1+ (two years in the river and one year in the sea)

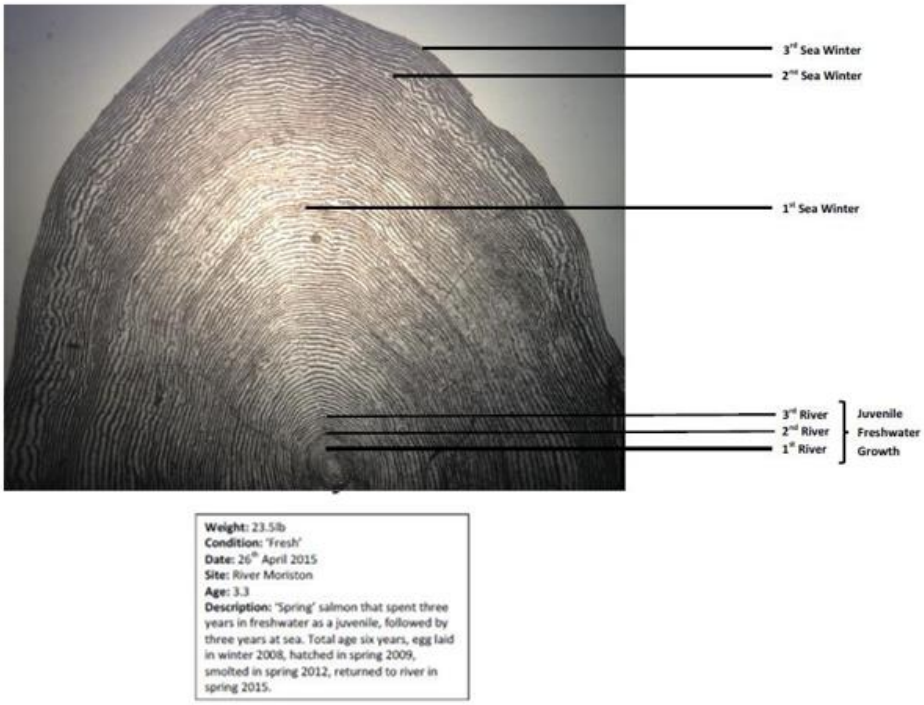


Fish that stay at sea for more than one winter return at a larger average size. These multi sea winter (MSW) salmon are believed begin returning very early in the year (sometime late November/early December in the previous year), compared to the main grilse run which usually return between June and October. Scales from typical MSW salmon are presented in **Figure 3.3**.

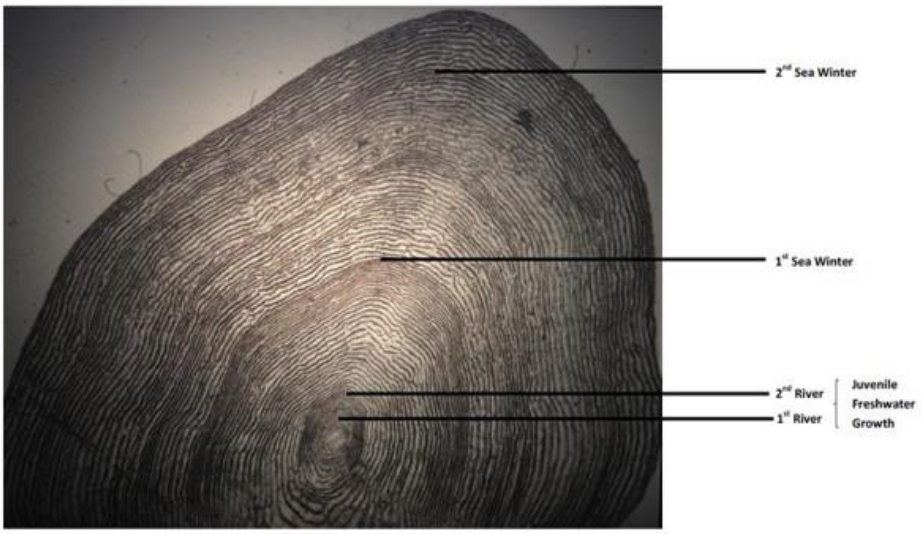
The first fish aged 3.3 years was captured in April and so is classed as a 'spring' fish. This is confirmed by the scale which shows no growth after the third sea winter check. This indicates that the fish entered the river early in the year without putting on any significant growth since the last winter.

The second fish was captured as a 'fresh' run fish in July and so is classed as a 'summer' salmon. This fish exhibits 'plus' growth after the second sea winter check, consistent with the fact that it had more time to feed at sea since the last winter.

Figure 3.3 - Scale from a 3.3 multi sea winter 'spring' salmon (above) and a 2.2+ multi sea winter 'summer' salmon (below).



Weight: 23.5lb
Condition: 'Fresh'
Date: 26th April 2015
Site: River Moriston
Age: 3.3
Description: 'Spring' salmon that spent three years in freshwater as a juvenile, followed by three years at sea. Total age six years, egg laid in winter 2008, hatched in spring 2009, smolted in spring 2012, returned to river in spring 2015.



Weight: 16.5lb
Condition: 'Fresh'
Date: 25th July 2015
Site: River Ness, Town Water
Age: 2.2+
Description: Summer salmon that spent two years in freshwater as a juvenile, followed by two plus years at sea. Total age four plus years: egg laid in winter 2010, hatched in spring 2011 and smolted in spring 2013. The fish then returned to river as an adult in summer 2015, having put on a little plus growth since its last sea winter.

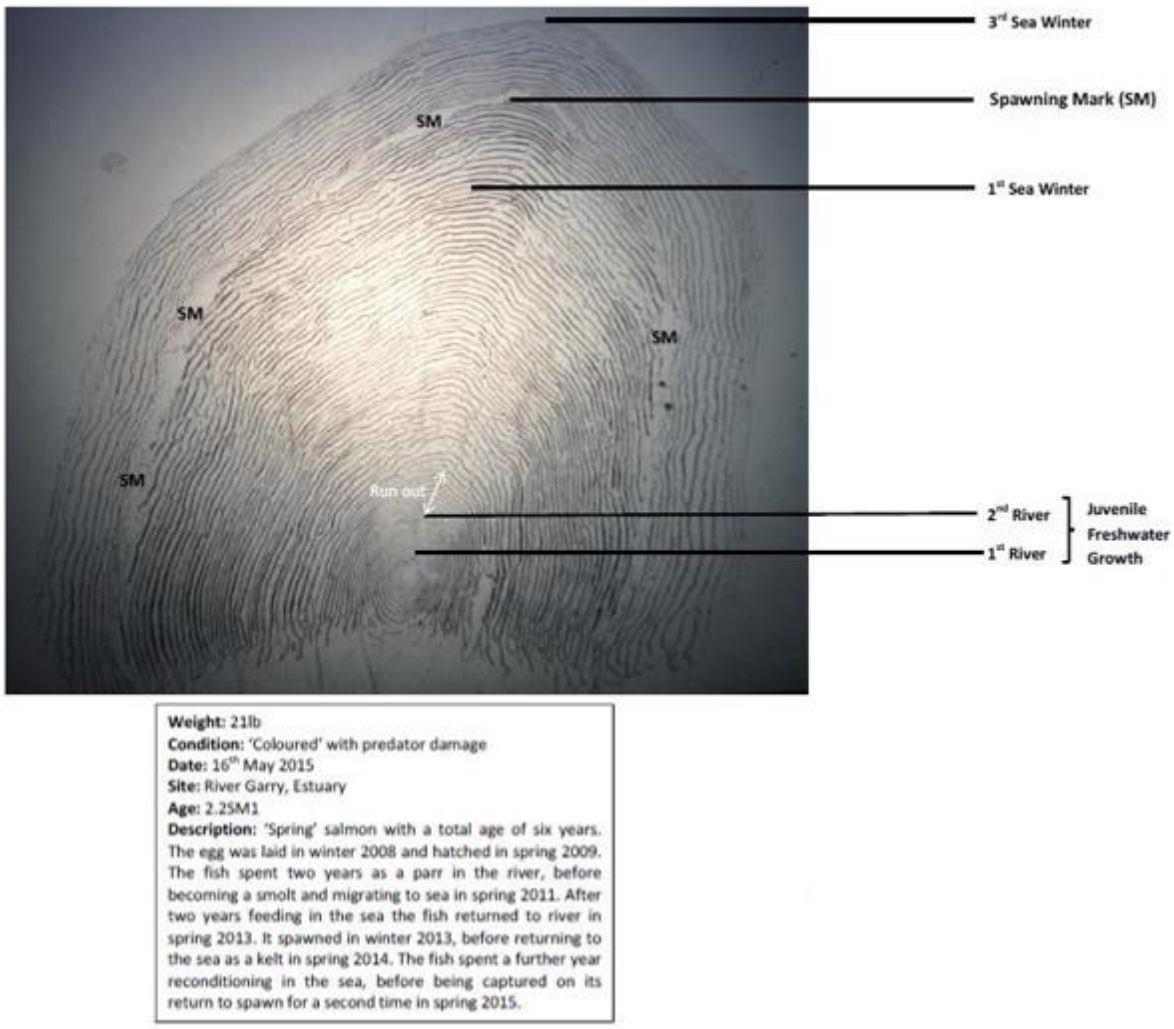
On their return to freshwater salmon do not feed, the mineralisation process is reversed and the scales are reabsorbed from the outside edge. This demineralisation process is known as the 'Crichton Effect' (after it was described by Crichton in 1935) and provides a source of calcium during periods of deficiency.

The erosion observed on a scale as a result of this process is called a 'spawning mark'. The degree of erosion can be used to given an indication as to how long a fish has been in freshwater, or to identify kelts, i.e. 'spent' fish which have spawned, survived and are on their way back to the sea (see **Figure 3.4** below).

Figure 3.4 - Scale from salmon 'kelt' with a high degree of erosion along its edges creating a 'spawning mark'.

The presence of a spawning mark can also be used to identify previous spawners, i.e. those fish that have entered the river and spawned, returned to the sea, then entered the river again to spawn for a second time. An example of a multi sea winter salmon scale exhibiting a previous spawning mark is presented in **Figure 3.5**.

Figure 3.5 – Impression of a scale from a 2.2(SM) 1 'repeat spawning' salmon.

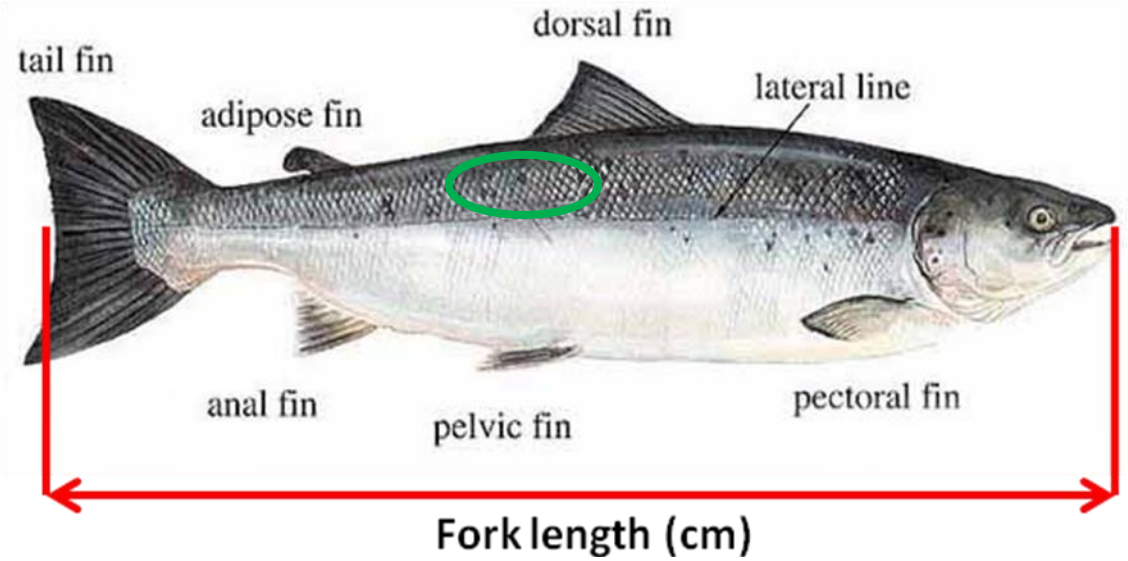


Weight: 21lb
Condition: 'Coloured' with predator damage
Date: 16th May 2015
Site: River Garry, Estuary
Age: 2.2SM1
Description: 'Spring' salmon with a total age of six years. The egg was laid in winter 2008 and hatched in spring 2009. The fish spent two years as a parr in the river, before becoming a smolt and migrating to sea in spring 2011. After two years feeding in the sea the fish returned to river in spring 2013. It spawned in winter 2013, before returning to the sea as a kelt in spring 2014. The fish spent a further year reconditioning in the sea, before being captured on its return to spawn for a second time in spring 2015.

4 SCALE SAMPLING PROCEDURE

Ghillies and anglers were issued with scale packets, tweezers and asked as a minimum to take samples from every third fish landed. Normal procedures for minimising trauma and damage to the fish were employed (e.g. minimum handling time and wet hands). The fish were kept under as much control as possible, preferably remaining in the landing net. The fish were weighed as usual and the anglers asked to record their 'fork length', measured from the tip of the snout to the fork of the tail (see **Figure 4.1** below).

Figure 4.1 Adult salmon showing fork length and scale sample area



The weight and length of the fish were recorded on the scale packet provided, together with the date and location of capture (the river, beat and pool from which it was taken). Further comments were included in the 'Remarks' section, together with the sex of the fish (if possible).

Scales were taken from the area highlighted in green (see **Figure 4.1** above) between the dorsal fin and lateral line. This ensures that the best possible shaped scales are taken making reading much easier. A total of four to five individual scales were removed from each fish. This allows the age to be verified and accounts for any 'replacement' scales. The scales were then transferred to the completed scale packet.

Scale packets were submitted to Ness and Beauly Fisheries Trust biologists. These were then given a reference number before being sent to a specialist scale reader (Bryce Whyte) for validation. The raw data was then sent back in a spreadsheet and subsequently analysed. A number of scales samples were photographed, with annotated images provided to those who captured the fish (see **Appendix 1**). The results are presented in the following sections of this report.

5 RESULTS

This section of the report presents the results of the 2015 to 2018 Beauly District Scale Sample Programme; including the numbers and quality of scale samples submitted and analysis of the resulting data in terms of month of capture and age composition.

5.1 SAMPLING EFFORT

Scale samples were submitted from a total of 232 adult salmon captured between 2015 and 2018, equating to 12.28 per cent of the total salmon catch for the period (1,890 fish). The details of each sample submitted are presented in **Appendix 1** of this report.

The results indicate that sampling effort was variable across the years of sampling with a peak of twenty four percent of the rod catches being scaled in year 2017. This peak was not related to a higher number of fish catches for that year but other factors e.g. better coordination collecting samples may have originated these results (**Table 1**).

Year	Number of scales	Number of catches	Sampled proportion (%)
2015	69	568	12.15
2016	45	551	8.17
2017	95	395	24.05
2018	23	376	6.12
Total	232	1890	12.28

Table 1 – Number of reported scales and rod catch in the Beauly system from 2015 to 2018.

Scale samples were taken from a higher proportion of the 'summer' catch than the 'summer' and 'autumn' catch Overall, the months of July, August and September coincides with the greatest number of fish captured and reported scales (see **Figures 5.2 to 5.3** below). In future years sampling effort should ensure sufficient scale samples early (March-April-May) and late (September-October) in the season as being the underreported periods. No rod catches were reported for the months of January and February thus there not exists scale samples for the winter period.

Figure 5.1 – 2015 to 2018 combined monthly rod catch for the Beauly system unit (blue) compared to the number of scale samples submitted (orange)

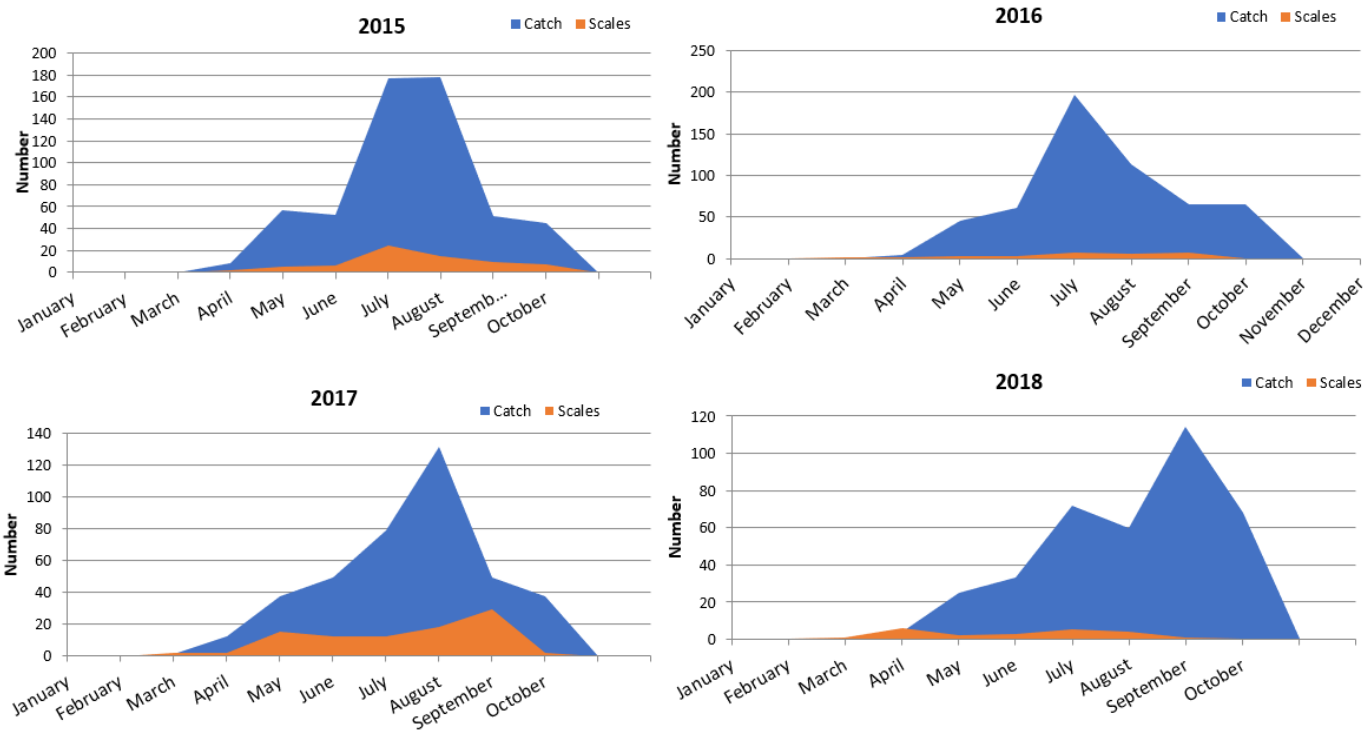


Figure 5.2 – Percentage of collected scales by month for the years 2015 to 2018.

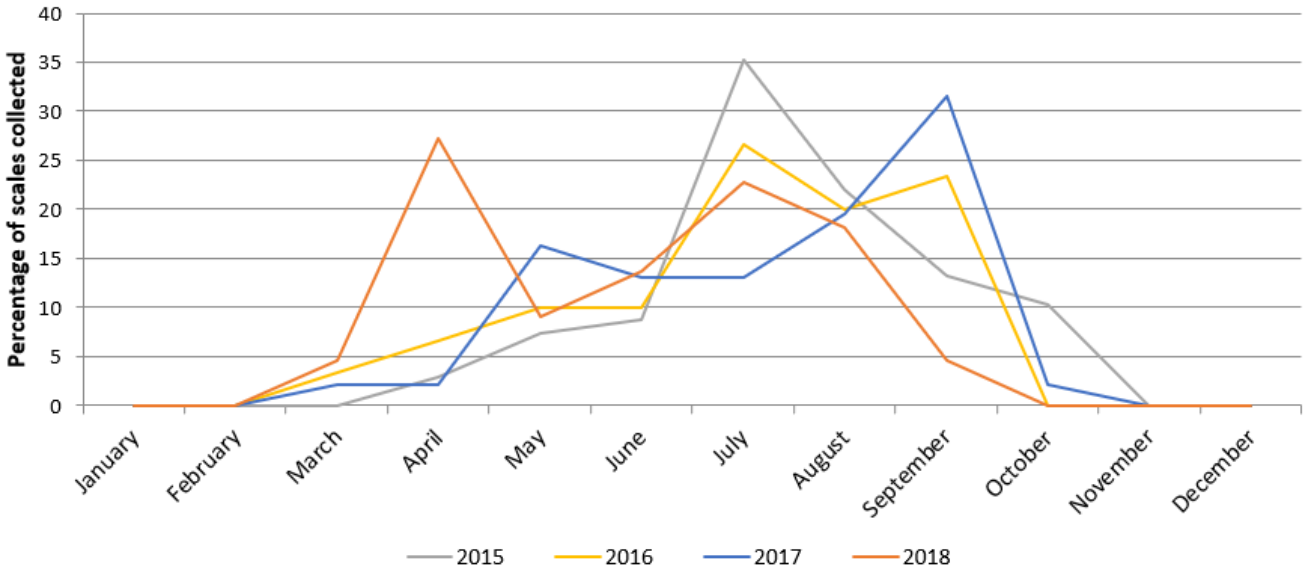
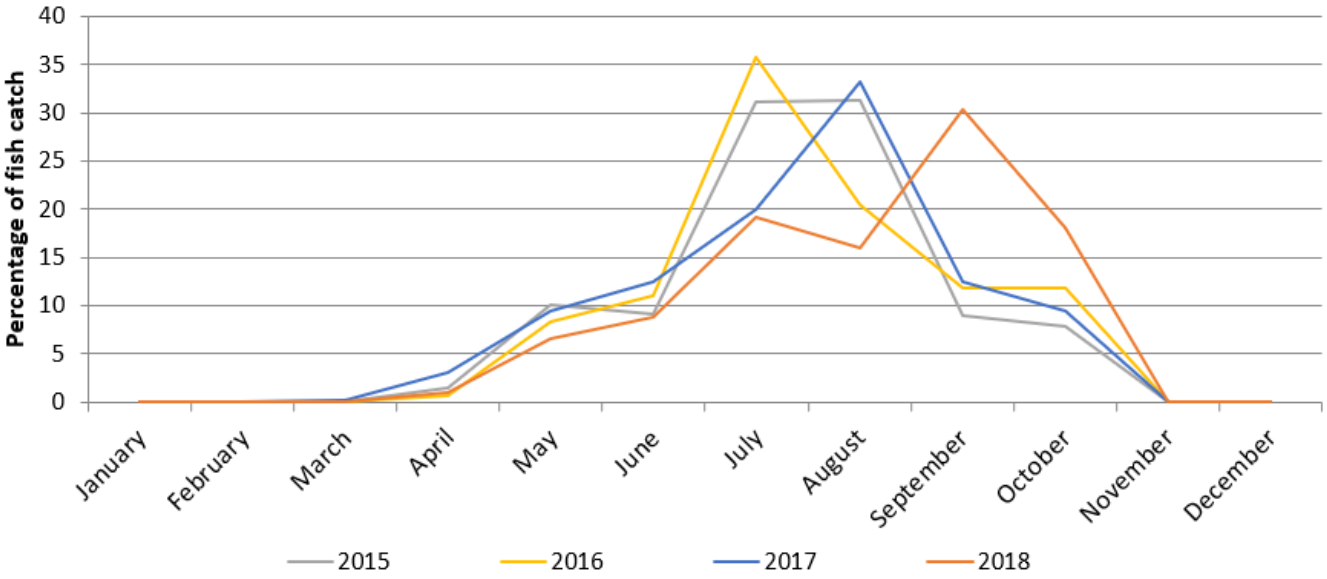


Figure 5.3 – Percentage of rod catches by month for the years 2015 to 2018.



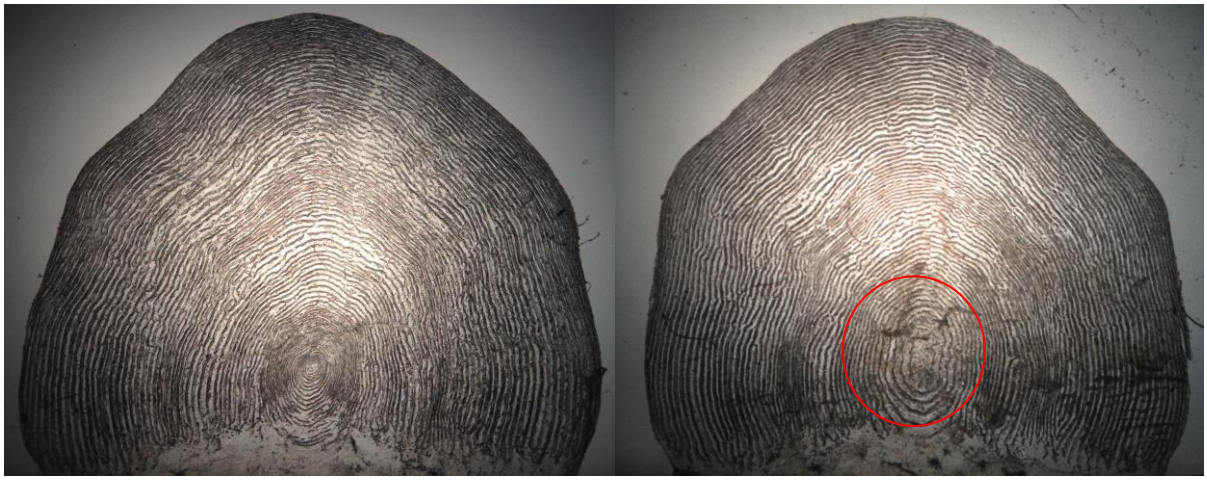
5.2 SAMPLE QUALITY

The length of fish has not been reported or just available in very few samples (<10) in the period 2015 to 2018. The causes of this misreporting are unknown and we are currently encouraging Beauly anglers to record the length of any catch fish. Future, scale programmes should consider distributing tape measures to anglers to improve the available information on salmon catches.

It was not possible to determine the freshwater age for 15 of the samples submitted between 2015 and 2018, with the marine age also indistinguishable in the case of five of these samples. In the majority of cases this was due to too few scales being contained in the envelope, with those present being 'replacement scales'

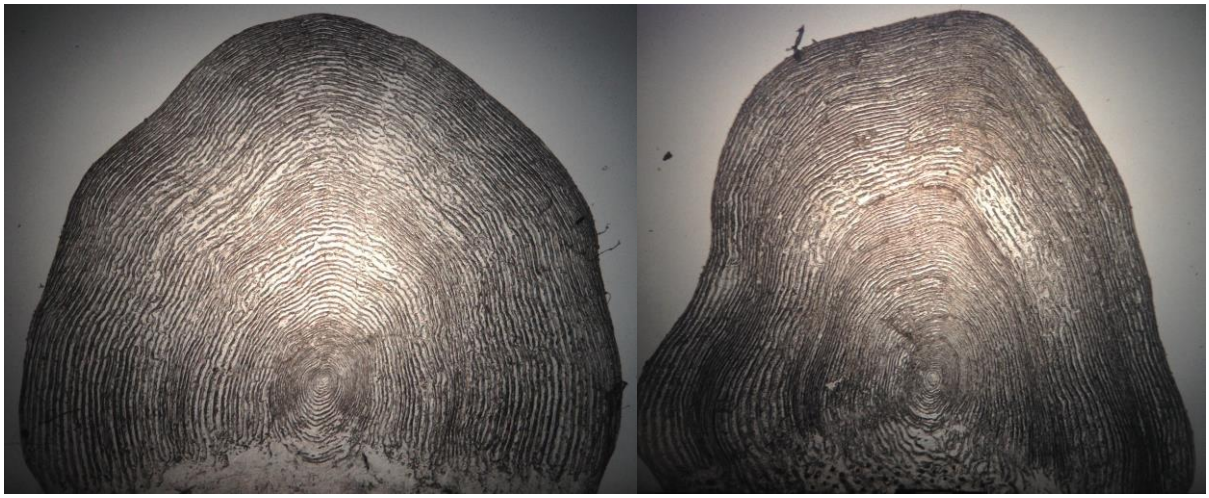
When a scale is lost, a replacement (regenerated) scale grows rapidly to reach the size of the original. Regenerated scales do not form circuli during the period of rapid growth and often appear clear, pebbly or irregularly formed compared to the original scale (see **Figure 5.4** below). When the regenerated scale reaches the size of the original, further growth occurs and circuli are formed at the same rate as the surrounding non-regenerated scales. Since they lack age and growth information prior to scale loss, ages estimated from regenerated scales are not reliable. The occurrence of replacement scales is the primary reason for need to take four to five scales from each individual fish.

Figure 5.4 – A normal scale (left) and typical 'replacement' scale (right) from the same fish. The replacement scale has irregularly formed regeneration in its centre making the freshwater age impossible to determine.



A number of scale envelopes contained 'irregular' shaped scales originating from sub-optimal locations on the fish (see **Figure 5.5** below). These are likely to have resulted from loose scales being taken from the landing net or river bank. Scales should be taken directly from the area between the dorsal fin and lateral line on the fish. This ensures that the best possible shaped scales are taken making reading much easier.

Figure 5.5 - Scale of the best possible shape taken from between the dorsal fin and lateral line (left) next to an irregularly shaped scale from another part of the fish (right).



5.3 KELTS

Scale samples from 3 fish sampled between 2015 and 2018 indicate that they were extracted from Kelts. These fish were excluded from the analysis as they were fish that entered the system in the previous year.

A kelt is a salmon which has spawned. They are usually identified by their thin shape, distended vent and presence of 'gill maggots' on the gill filaments (see **Figure 5.6** below). They are often encountered by anglers in spring when they regain a silvery appearance and can be easily mistaken for fresh run 'springers'.

Figure 5.6 - A typical female salmon kelt with thin shape yet silvery appearance

5.4 PREVIOUS SPAWNERS

No previous spawners were caught in the Beauly system over the 5 years period.

In Scotland it is unusual to see more than two spawnings by an individual fish; however, fish with up to four spawnings have been identified in Norwegian rivers.

Repeat spawning fish are important for the entire river stock for a number of reasons:

- Older salmon are larger and have a better chance of spawning successfully;
- The larger females are more aggressive and capture the optimum spawning sites in the river,

improving the chances of spawning success;

- The larger the hen salmon, the more fecund it will be (i.e. it will deposit a larger number of eggs);
- Large salmon are known to be more attractive to other fish than the smaller ones and so the eggs are more likely to be fertilised;
- The larger the salmon the bigger the eggs, providing the fry with a larger food reserve and increasing survival; and
- The larger the salmon, the deeper the nest or 'redd', making it more resilient to the impacts of high or low water conditions.

These 'veterans' are acting to 'fill the gaps' left by poor returns of maiden spawners. They also remind us of the importance of returning as many spring salmon as possible. By removing even the smallest of fish you may prevent it from spawning not just once, but even two or three times.

5.5 FISH FARM ESCAPEES

No fish farm escapees were identified from the scales samples collected between 2015 and 2018. However, escapes from fish farms are a cause for concern and anglers should know how to identify them.

For conservation and wild fish interests, escaped fish may: represent a disease hazard; occupy valuable habitat to the exclusion of wild fish; and have the potential to interbreed with wild fish, leading to dilution of genetic integrity.

Farmed salmon can differ morphologically from wild salmon in several ways:

- Shortened gill covers such that the gills are visible when the covers are normally closed;
- Snout/jaw deformations;
- Bud fins (when dorsal or pectoral fins are worn down to a cartilage-like stump where the rays are no longer visible);
- wavy rays on dorsal or pectoral fins;
- Rounded tail lobes; and
- Higher numbers of dark spots below the lateral line.

Photographs of a typical escaped farm salmon is shown in **Figure 5.7** below. This illustrates the shortened gill cover, wavy rays on pectoral fins and damaged dorsal fin.

Figure 5.7 - A confirmed fish farm escapee with shortened gill-cover, wavy rays on pectoral fin and damaged dorsal fin.

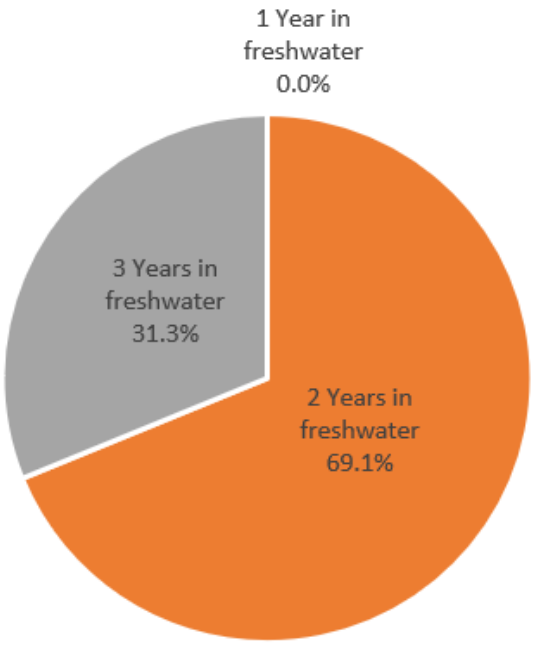
5.6 AGE COMPOSITION

The sea ages of Atlantic salmon indicate crucial differences between oceanic feeding zones, which have important implications for conservation and management (Bacon *et al*, 2010). It is also known that '1 Sea Winter (1SW) grilse' and 'Multi Sea Winter (MSW) salmon' can have different freshwater habitat preferences (lowland and upland areas respectively). An understanding of the age composition of a salmon therefore provides important details regarding their lifestyles and requirements of the fish and their populations (Bacon *et al*, 2010).

5.6.1 Freshwater Age

It was possible to determine the freshwater age for 217 of the scale samples submitted between 2015 and 2018. The majority of these fish (69.1 per cent) were found to have spent two years in freshwater before migrating to the sea (see **Figure 5.8** below). A further 31.3 per cent were found to have spent three years in fresh water.

Figure 5.8 - Proportion of sampled rod catch (2015 to 2018) shown by years spent in freshwater



Each spring, the largest parr become silvery smolts and migrate downstream towards the sea. In the southern rivers of the United Kingdom this can happen after just one year. In the more northerly Scottish rivers (which have shorter growing seasons) smolts are usually two to three years of age, as is the case in the Beauly District.

Studies of salmon scale samples taken from other rivers in Scotland indicate that a greater proportion of fish with three freshwater years (and above) are found to originate from the upper reaches of rivers than the lower reaches. This is thought to be due to the colder climate in these

areas and subsequent lack of nutrients resulting in slower growth rates of fry and parr. This pattern seems dissimilar in the Beauly system with the proportion of three freshwater year fish being very similar in the Beauly and the Farrar rivers (see **Figure 5.9** below). However, further analyses indicated that three freshwater year fish were predominantly recoded in April and October (40 per cent of monthly sample) and ranging from 20 to 34% in other months (see **Figure 5.10** below). Additionally, the remarks on the scale samples indicated that all the "coloured" fish were either originated from the rivers Farrar and Glass in the months of September and October while the vast majority of "fresh" fish were captured early in the Spring in the Beauly. Overall these results are suggesting that the three-year-old class may have being caught early the Spring in the Beauly while migrating to the upper reaches and advocates more research e.g. by using fish telemetry methods (Pit/Acoustic tags).

Figure 5.9 - Proportion of sampled rod catch (2015 to 2018) on each main tributary of the Beauly District found to have spent two and three years in freshwater

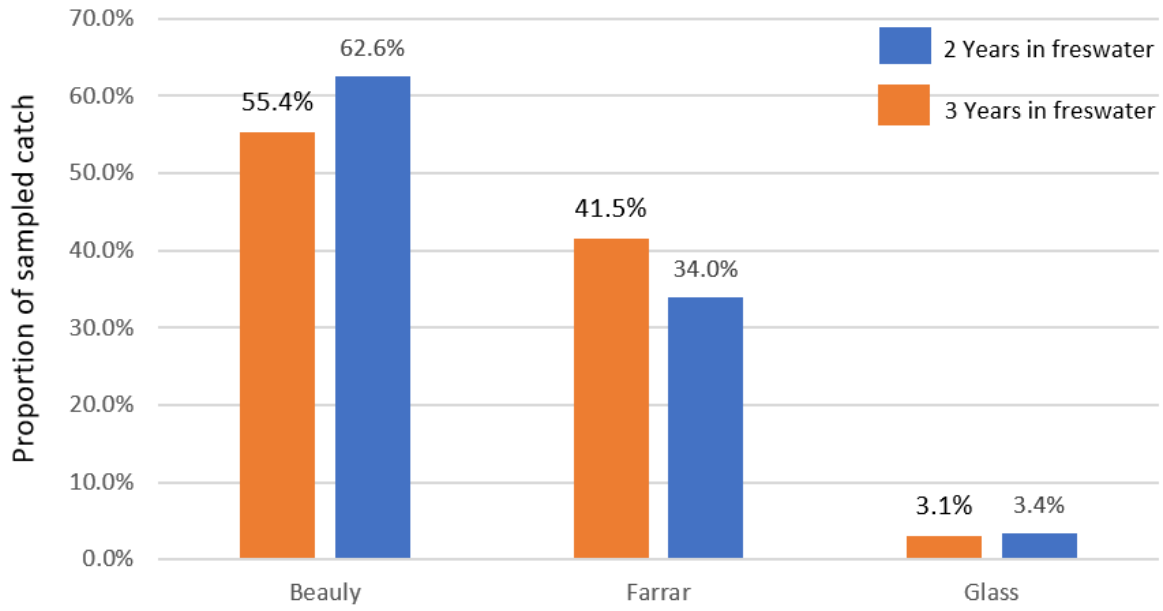
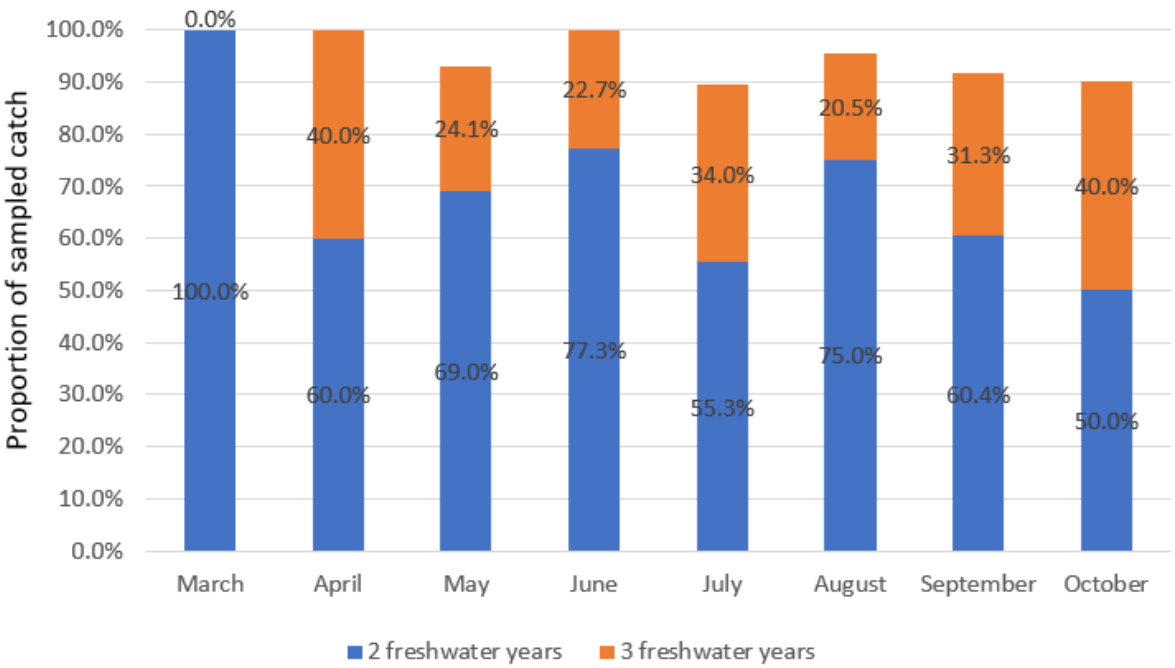
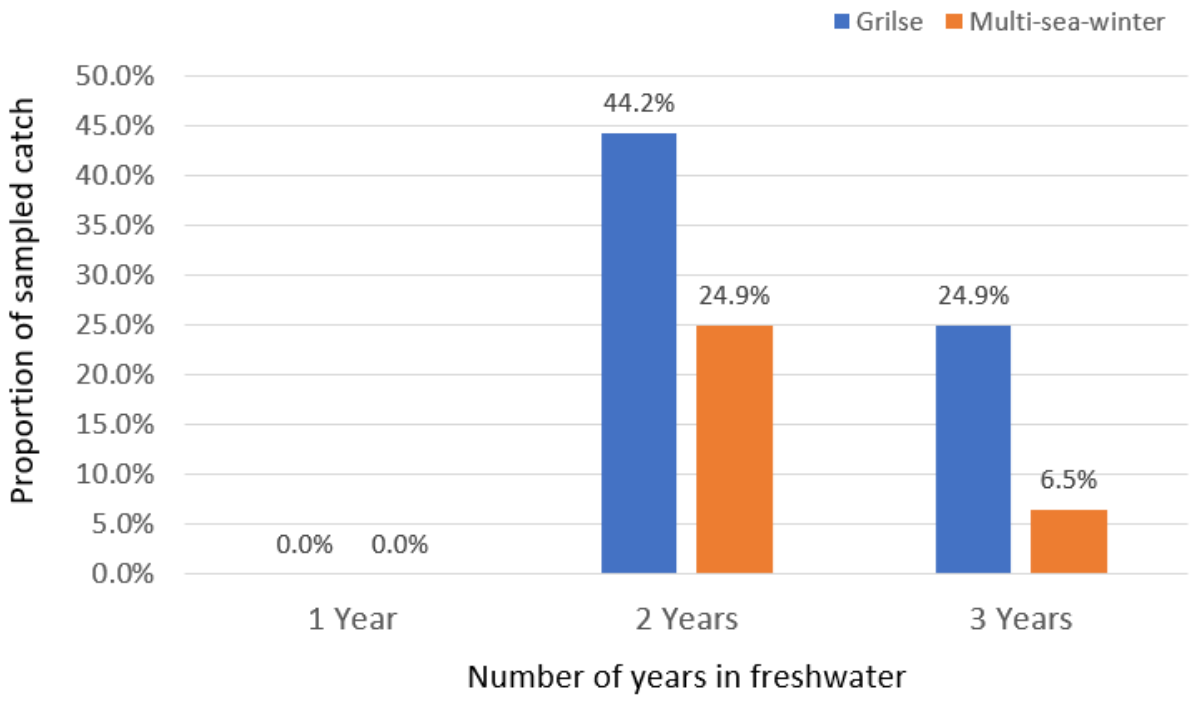


Figure 5.10 - Monthly proportion of sampled fish falling into each freshwater age class



A large number of grilse sampled between 2015 and 2018 (44.2% per cent) were found to have spent two years in freshwater as juveniles (See **Figure 5.11** below). Same pattern is observed in multi-sea-winter adults with the two-year-old fresh water class being the majority. Low proportion of multi-sea-winter salmon was originated from the 3-year-old juveniles. This pattern seems to be opposite from observations on other river systems (e.g. in the Ness system where usually more three fresh water year fish in the multi-sea-winter component (19% of sampled catch), particularly from the upper reaches of a catchment). This could be explained by particular conditions in the Beauly system that favours the survival 2-year emigrating smolts. This may be related with the appropriate time window for smolt migration for the sea. If fish are not able to enter the sea when the conditions at sea are adequate (e.g. temperature, food resources, etc.) this can lead to lower survival of juvenile fish at sea. Thus, factors influencing the timing of smolt migration in the river (e.g. hydroelectrical dams) should be considered in order to enhance the multi-sea winter component in the Beauly catchment.

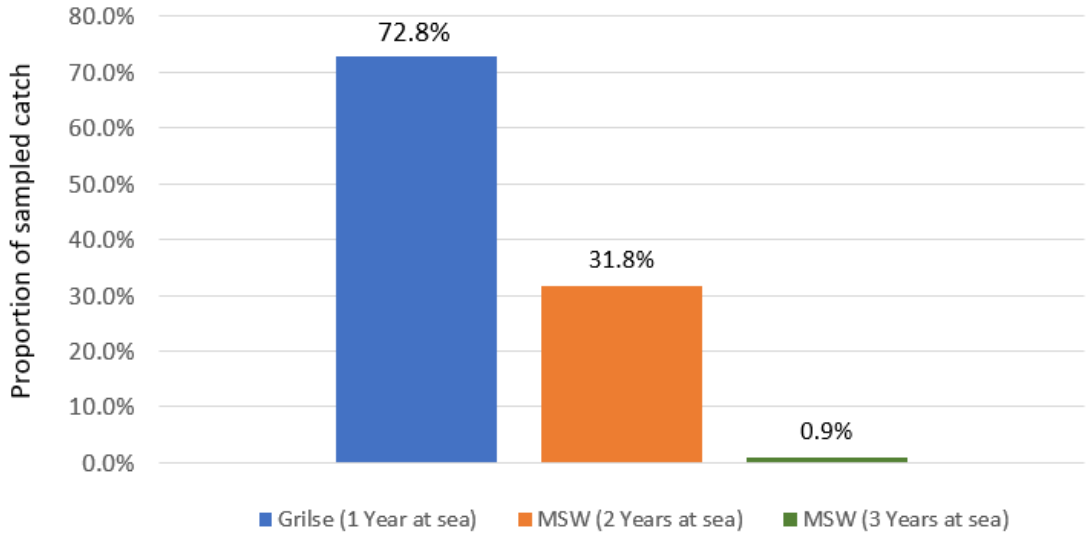
Figure 5.11 - Proportion of scales sampled from grilse (1SW) and salmon (MSW) falling into each freshwater year class



5.6.2 Sea Age

Grilse was the most representative group on the collected salmon scales in the Beauly system followed by 2 years at sea MSW and 3 years at sea MSW fish (See **Figure 5.12** below). This result differs from what is observed in the Ness system where the majority of the fish (84%) correspond to multi-sea-winter fish. The causes of these differences are difficult to be elucidated by scale sampling; however, these results emphasize the importance of preserving the rare multi-sea-winter component in the Beauly system as being crucial for the long-term sustainability of the salmon stock in the catchment.

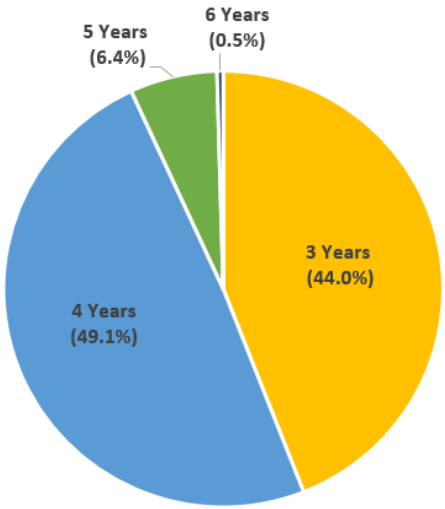
Figure 5.12 - Proportion of scales sampled from grilse (1SW) and salmon (MSW) falling into each sea year class



5.6.3 Total Age (Freshwater and Sea Combined)

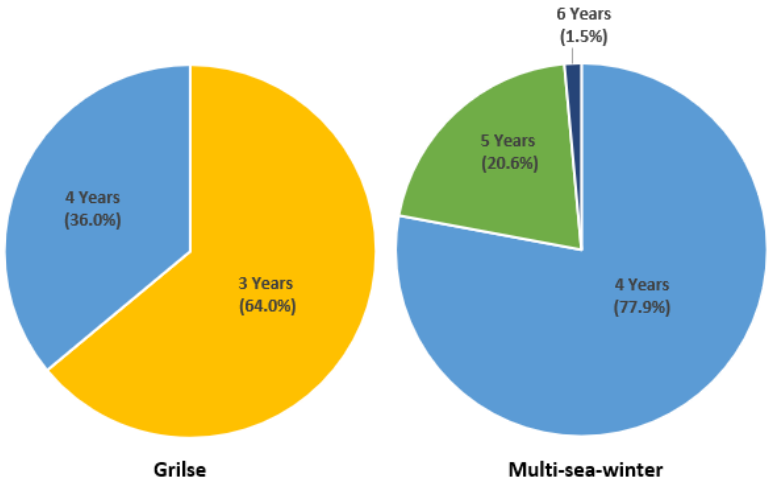
The majority of fish sampled between 2015 and 2018 were classified as either three (44%) or four years (49.1%) based on the combined freshwater and sea age (see **Figure 5.13** below). Older fish classes were rare in the system i.e. 5 and 6 years combined age. The six-year-old fish was regarded to be a Kelt caught in the Beauly Angling Club beat in April 2015.

Figure 5.13 - Proportion of sampled rod catch (2015 to 2018) shown by combined freshwater and sea or total age



Furthermore, the majority of Grilse was classed as 3 Years (64%) while the typical combined age for a MSW fish is 4 Years (77.9%) (**Figure 5.14)**.

Figure 5.14 - Proportion of 1SW grilse (left) and MSW salmon (right) falling into each 'total' age class



5.7 ADULT RUN TIMING

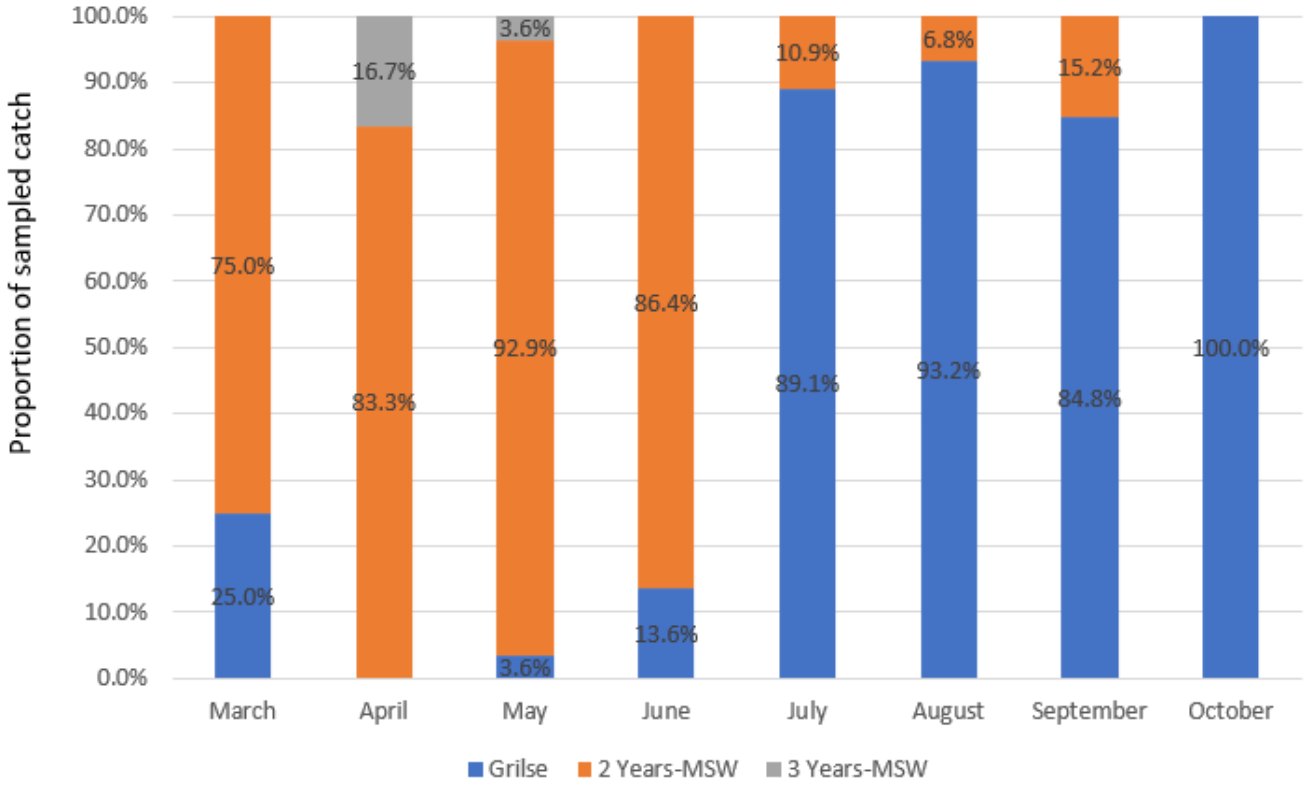
Research has shown that the spawning destination of salmon can be related to timing of river entry. Early run fish are known to travel further upstream, with later running fish remaining lower in the catchment (Bacon *et al*, 2010). Diversity in adult run timing is particularly important in terms of ensuring the longevity of the salmon population, but also the economics of a fishery as it extends the fishing season (Bacon *et al*, 2010). Information gained from scale reading regarding run timing is therefore of particular interest.

5.7.1 Relative Proportions of 1SW and MSW Fish

Analysis of scale samples taken from fish caught in the Beauly system from 2015 to 2018 resemble the typical upstream run of salmon to freshwater in which a large proportion of the multi-sea-winter fish are being recorded early in the season (months March to June) with Grilse being recorded later (from June onwards) (see **Figure 5.15** below). Finally, the presence of 3 Year MSW fish is low and restricted to the months of April and May.

It is important to note that March samples were underrepresented (n= 4) and that only one single individual was characterized as Grilse thus not being relevant for the observed general pattern (described above).

Figure 5.15 - Relative proportions of 1SW, 2SW and 3SW fish identified from scale samples taken in each month of the season



5.7.2 Plus Growth

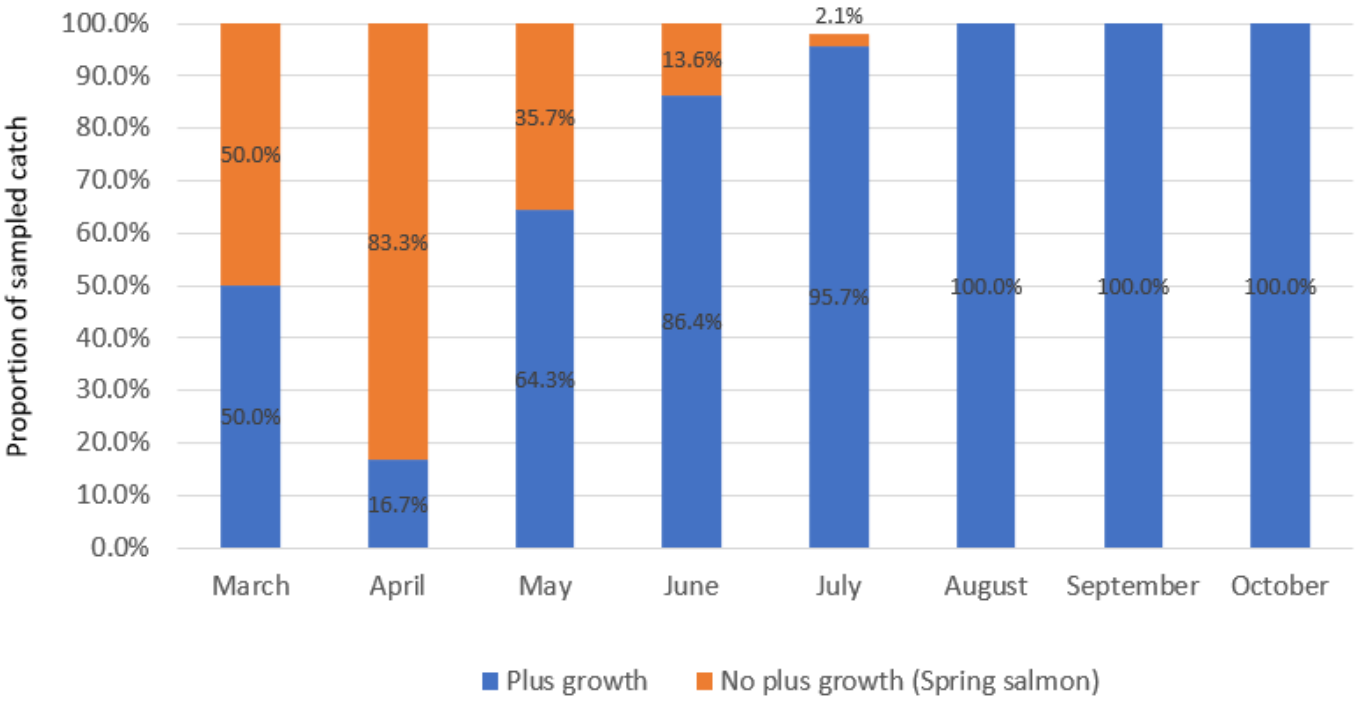
'Plus growth' refers to the amount of growth shown on the fish scale since the last winter check. Fish entering the river during the early 'spring' period do so before they have the opportunity to feed and so show little or no growth since the last winter check. The fish that enter the river later in the year (such as grilse and summer/autumn salmon) spent longer feeding at sea and so their scales exhibit a much greater degree of growth since the last winter check.

This difference in the amount of plus growth on a scale enables 'spring' salmon to be identified. This is illustrated in **Figure 5.16** below, which presents the relative proportion of scale samples showing either 'no plus growth' or 'plus growth'.

It is important to bear in mind that due to the low number of scale samples obtained in March (n=4) the proportion of fish in this group may not be representative. Otherwise, the scale samples indicate that the majority of the sample catch in April was dominated by no plus growth fish or "Spring salmon". Furthermore, no plus growth fish were also recorded in lower proportions in May (35.7%), June (13.6%) and July (2.1%). On the other hand, there exists evidence of plus growth fish in each of

the sample months ranging from 16.7 % in April to dominate all the sampled catch by July/August.

Figure 5.16 - Proportions of scale samples showing either 'no plus growth' or 'plus growth'.

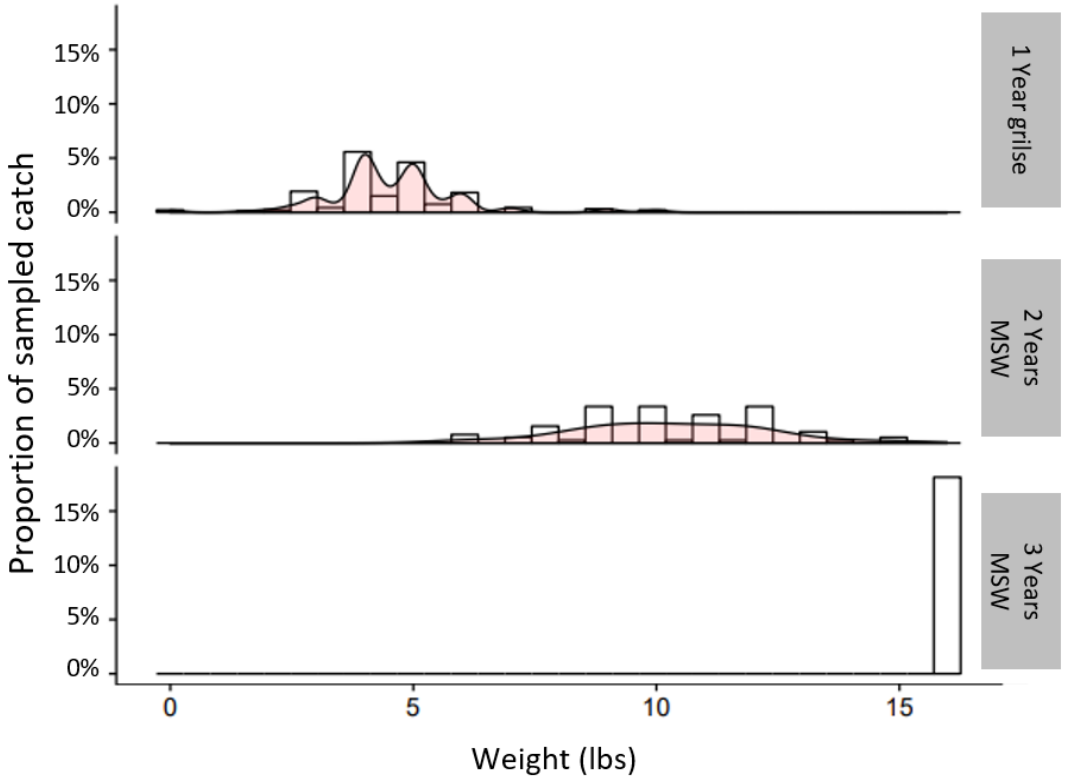


Overall these results demonstrate that scale reading can be used to identify and protect vulnerable 'spring' fish throughout the season. In particular, the results of the 2015 to 2018 scale sampling programme, together with analysis of the latest five-year average monthly rod catches, indicate that the months of April and May are significantly important for spring salmon on the Beauly system. This reinforces the need for The Scottish Government's statutory conservation measures for 'spring' fish (all fish must be returned up to the 1st April) in the Beauly system and to comply with the 'Beauly District Salmon Conservation Policy' i.e. not kill 'coloured' fish. Further to this, it confirms the presence of 'spring' salmon in the Beauly system.

5.7.3 Fish size (weight)

The scales samples collected between 2015 and 2018 provide information relating to the size ranges (in terms of weight) of both salmon and grilse (see **Figure 5.17** below).

Figure 5.17 - Size ranges of 1SW Grilse, MSW salmon sampled between 2015 and 2018



Fish in the sample aged as grilse (1SW) were found to range between 1.5 and 10 pounds in weight, with an average weight of 4.6 pounds. The 2SW salmon ranged from 6 to 15 pounds, with an average weight of 10.2 pounds. The only reported weight for a 3SW salmon was 16 pounds.

If we assume that these samples are representative of the wider salmon population in the Beauly system, then the results suggest that fish over 9 pounds are most likely to be MSW salmon, with fish under 5 pounds most likely being 1SW grilse. Fish between 5 and 10 pounds could be either MSW salmon or grilse and difficult to positively identify without scale reading.

The systematic misreporting of grilse as MSW salmon (or grilse error) is a problem associated with Scottish rod fisheries in the summer and autumn months (Shearer, 1992; MacLean, Smith and Laughton, 1996). This bias can have significant consequences for the management of salmon stocks in terms of over representation of MSW salmon.

This is important because a greater proportion of MSW than grilse are known to be female. The use of uncorrected data could lead to an overestimate of the number of spawning females and the eggs that they produce. This has significant implications with regards to the setting of conservation limits for salmon.

There is currently little information available regarding the variation in grilse error across the country. The current Marine Scotland Science model for calculation of conservation limits uses the data from MacLean, Smith and Laughton (1996) who examined grilse error on two beats of the River Spey. A slight amendment to the data collected as part of our scale sampling programme would allow us to examine Beauly District wide and specific tributary grilse error. This would require the use of a scale packet which asks for length data together with a description of the fish in terms of salmon or grilse.

5.7.4 Length/Weight Relationship

With voluntary catch and release now throughout much of the season on the Beauly system, it is important that anglers reduce handling time and return fish as quickly as possible. The ability to determine the weight of a fish using its length (which can easily be measured in the landing net) rather than actually weighing it can significantly reduce handling while providing important information.

Catchment specific salmon weight/length conversion charts have proven to be very popular. The majority of these charts were developed using data collected on the River Dee in Aberdeenshire. There is however some indication that the Dee fish have a different length to weight ratio in other rivers in Scotland e.g. in the River Ness (particularly the larger fish). Furthermore, it is possible that different sub-populations of salmon across the Beauly system have different weight/length ratios. It is therefore recommended that, as a minimum, the length and weight data collected during scale sampling be used to develop a 'Beauly Specific' Length/weight conversion chart.

Over time it would be possible to use the information collected as part of the scale sampling programme to assign weights to fish photographed as they pass through the fish counters. This would be achieved by determining the length of the fish using image analysis software (see **Figure 5.18** below).

Figure 5.18 - Example of the use of image analysis software to determine the length of fish passing a fish counter.

The length/weight conversion chart could then be used to assign a weight to the fish, with head shape and/or sex data used to give an estimate of sex ratio and subsequent egg deposition.

5.7.5 Sex Ratio

Conservation limits are expressed in terms of egg requirement per unit area of river. This requires information regarding the number of female salmon returning to a particular area of river, with the total number of spawners adjusted using information on the sex ratio of returning salmon.

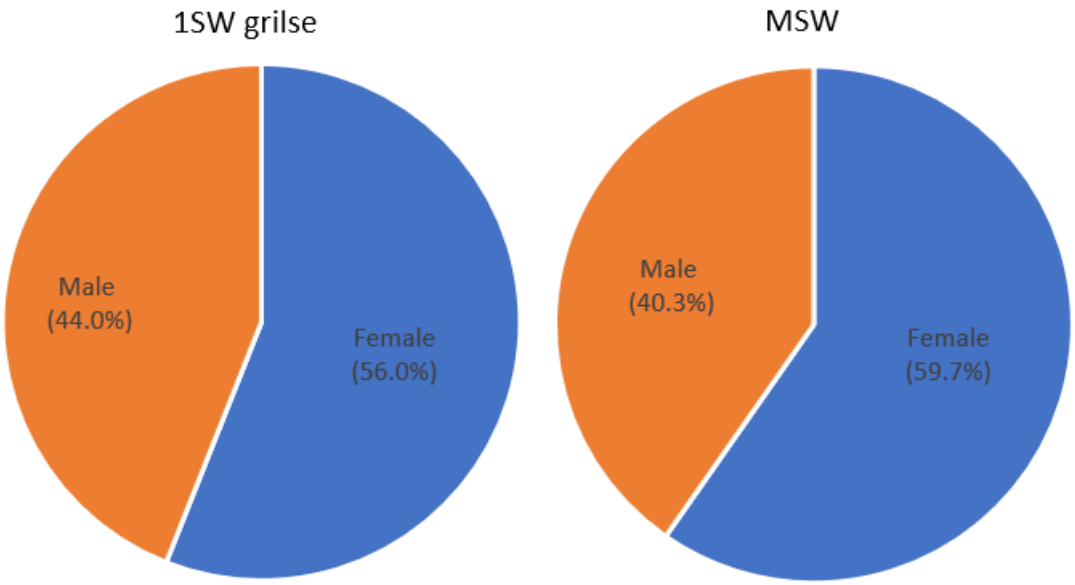
Few accurate data sets are available regarding the proportion of females returning to Scottish rivers. This is largely due to the difficulties in ascribing sex to salmon based on physical characteristics before they enter the breeding phase (see **Figure 5.19** below).

Figure 5.19- Fresh run male (left) and female (right) Atlantic salmon; head shape can be an effective way to ascribe sex before they enter the breeding phase.

The sex of fish was recorded on the majority of the sample packets submitted (99%) between 2015 and 2018 . Overall, females were found to account for 56.8% per cent of the total sample. Further, similar percentages of females and males where found across the grilse and MSW groups (see **Figure 5.20** below). This finding is surprising because generally a greater proportion of MSW than grilse are known to be female. However, given the difficulties assessing the sex of the fish it is premature to draw any firm conclusions based on this result advocating more research.

Increasing sampling effort in the spring/autumn periods and routinely recording the sex/weight/length of fish on all scale packets would allow us to start building up a better picture of the proportions of male and female spawners in terms of grilse and MSW salmon. It may then be possible to apply this to other data sets such as rod catches and fish counts from the Kilmorack and Aigas counters, allowing an estimate of total egg deposition.

Figure 5.20 - Relative proportions of male and female salmon identified by anglers when submitting scale samples from 1SW grilse and MSW salmon caught between 2015 and 2018



6 PRACTICAL MANAGEMENT APPLICATIONS

A key challenge facing Scottish fishery managers is the ability to balance the conservation of stocks of MSW salmon, whilst still maintaining an economically viable fishery (Bacon *et al*, 2010). The information gained from scale reading, combined with length and weight data, can be used to inform management decisions which help to achieve this. Two particularly topical practical applications are illustrated in further detail below.

6.1 SPRING CONSERVATION MEASURES

In line with recommendations contained in the Wild Fisheries Review group's report regarding declining spring salmon catches and following a consultation period, the Scottish Government introduced statutory conservation measures to ensure that no salmon are taken in Scotland before 1st April each year. The national measure came in to force on Friday 9th January 2015, the key elements of which are detailed below:

- The annual close time has been extended until 31st March;
- The start of the net fishing season is delayed until 1st April;
- Fishing by rod and line can take place from the season start date within the district until 31st March on a catch and release basis (any salmon caught must be returned to the water with the least possible harm);
- The measures seek to underpin any existing voluntary/statutory measures; and
- The measures will be reviewed annually.

The results of the 2015 to 2018 scale sampling programmes indicate that the Scottish Government's spring conservation measures do not go far enough. As the regulations currently stand, all fish must be returned up to the 1st April and there still exits a significant proportion of the very valuable spring salmon still recorded in May. This information may support an extension of the spring conservation period to the 1st July.

7 RECOMMENDATIONS

- Ghillies should continue to take adult scale samples from an unbiased sample of the rod fishery. This can be achieved by sampling strategically (e.g. every 2nd to 3rd fish landed). This will avoid any 'choice' in which fish to sample;

- Details of length, weight, date of capture, place of capture, sex, MSW salmon/grilse, condition of fish and any further remarks that the captor may have should be included on all scale samples submitted. This will increase the overall usable sample size and allow more detailed analysis;

- An adequate number of scales (four to five) should be taken from the optimum scale sample area to ensure the best possible shaped scale and allow the full age profile of the fish to be determined. Reliance on taking loose scales from the landing net should also be avoided;

- Scales samples should be taken from fish caught throughout the season. This is particularly true during the spring and autumn period, which is currently under represented. In addition to this, it is important that scale samples are taken from the full-size range of fish (both MSW salmon and grilse). This will add extra accuracy to any future length/weight conversion chart;

- The results of scale samples taken during the period when MSW fish and early running grilse overlap should be carried out as early as possible and the results made available to anglers and ghillies. This will help to protect smaller MSW, fish which could be confused with grilse. This should perhaps include the recording of other characteristics to aid field identification;

- Scale reading should be used to investigate the captures of 'spring' fish throughout the season, particularly on River Glass which is currently under represented;

- Recording a description of the fish in terms of salmon or grilse will allow the examination of 'grilse error' across the Beauly system;

- Recording the sex of fish on the scale packets will allow us to build a picture of the proportions of male and female spawners, informing an estimate of total egg deposition; and

- The production of a Beauly specific 'Length/Weight Relationship Chart' populated with scale reading data taken over a number of years would be useful. It could also be used to assign a weight to fish photographed whilst passing through fish counters, with head shape and/or sex data used to give an estimate of sex ratio and subsequent egg deposition.

8 REFERENCES

Bacon, P. J., Gurney, W. S. C., McKenzie, E., Whyte, B., Campbell, R., Laughton, R., Smith, G., and MacLean, J. (2010) Objective determination of the sea age of Atlantic salmon from the sizes and dates of capture of individual fish. *ICES Journal of Marine Science, doi:10.1093/icesjms/fsq142.*

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APPENDIX 1

2015 Scale Samples

ID	Weight	Sex	Fresh water	Sea	Plus	Month	Beat	System	Site	Erosion	Sea lice	Red Vent	Predation	Condition
1	4	NA	3	1	Yes	September	BAC	Beauly		4	No	No	No	No coloured
2	4.1	Male	2	1	Yes	September	BAC	Beauly	Beat 2	NA	Yes	No	No	No coloured
3	8	Female	2	2	No	April	Lower Beauly	NA	Glide pool	NA	No	No	No	No coloured
4	12	Male	3	2	No	May	Beauly	NA	Dam	NA	Yes	No	No	No coloured
5	16	Male	2	3	No	May	North run	Beauly	North run	NA	Yes	No	No	No coloured
6	NA	Female	3	3	No	April	BAC	Beauly	Bt3	5	No	No	No	No coloured
7	13	Male	2	2	Yes	May	Falls	Beauly	Ferry	NA	Yes	No	No	No coloured
8	8	Male	2	2	Yes	June	Falls	Beauly	Stones	NA	Yes	No	No	No coloured
9	12	Female	2	2	Yes	June	Falls	Beauly	Ferry	NA	No	No	No	No coloured
10	10.5	Male	2	2	Yes	June	Home Beat	Beauly		NA	No	No	Yes	No coloured
11	8.5	Female	3	2	Yes	June	Falls	Beauly	Ferry	NA	No	No	No	No coloured
12	11	Female	3	2	Yes	June	Falls	Beauly	Dam	NA	No	No	Yes	No coloured
13	11.5	Male	3	2	Yes	May	BAC	Beauly	Beat 2	NA	No	No	No	No coloured
14	5	Male	2	1	Yes	July	Falls	Beauly	Ferry	NA	No	Yes	No	No coloured
15	6	Female	2	1	Yes	July	Falls	Beauly	Glide	NA	No	No	Yes	No coloured
16	5	Female	NA	1	Yes	July	Falls	Beauly	Ferry	NA	Yes	No	No	No coloured
17	5	Female	NA	1	Yes	July	Falls	Beauly	Ferry	NA	Yes	No	No	No coloured
18	9	Male	3	1	Yes	July	Beauly	NA	Dam	NA	Yes	No	No	No coloured
19	9	Female	2	2	Yes	July	Falls	Beauly	Ferry	NA	Yes	No	No	No coloured
20	9	Female	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
21	9	Female	2	2	Yes	July	Falls	Beauly	Ferry	NA	No	No	No	No coloured
22	4.5	Female	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
23	5	Female	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
24	4	Female	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
25	5	Female	3	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
26	4.5	Male	3	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
27	5	Female	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
28	5	Male	2	1	Yes	July	Falls	Beauly	Ferry	NA	No	No	No	No coloured
29	5.5	Male	2	1	Yes	July	Falls	Beauly	Dam	NA	No	No	No	No coloured
30	5	Female	3	1	Yes	July	Falls	Beauly	Ferry	NA	No	Yes	No	No coloured
31	5	Female	2	1	Yes	May	Falls	Beauly	Stones	NA	No	No	No	No coloured
32	7	Male	3	1	Yes	July	Falls	Beauly	Glide	NA	No	No	No	No coloured
33	5	Male	3	1	Yes	July	Falls	Beauly	Ferry	NA	No	No	No	No coloured
34	4	Female	2	1	Yes	July	Falls	Beauly	Ferry	NA	No	No	No	No coloured
35	5	Female	2	1	Yes	July	Falls	Beauly	Glide	NA	No	No	No	No coloured
36	5	NA	2	1	Yes	September	BAC	Beauly	Beat 1	NA	No	No	No	No coloured
37	4.5	Female	2	1	Yes	August	Falls	Beauly	Ferry	NA	No	No	No	No coloured
38	5	Female	NA	1	Yes	August	BAC	Beauly	Beat 1	NA	Yes	No	No	No coloured

39	4.5	Female	2	1	Yes	August	Home Beat	Beauly		NA	No	No	No	No coloured
40	5	Female	3	1	Yes	August	Falls	Beauly	Glide	NA	No	No	No	No coloured
41	5	Female	2	1	Yes	August	Falls	Beauly	Ferry	NA	No	No	No	No coloured
42	5.5	Male	2	1	Yes	August	Falls	Beauly	Ferry	NA	No	No	No	No coloured
43	4	Female	2	1	Yes	August	Downie Beat	Beauly		NA	No	Yes	No	No coloured
44	5	Female	2	1	Yes	August	Falls	Beauly	Stones	NA	No	Yes	No	No coloured
45	5.5	Male	3	1	Yes	August	Falls	Beauly	New Pool	NA	No	Yes	No	No coloured
46	4	Female	2	1	Yes	August	Home Beat	Beauly		NA	No	Yes	No	No coloured
47	9	Female	2	2	Yes	September	Home Beat	Beauly		4	No	No	Yes	No coloured
48	6	Male	2	2	Yes	September	Downie Beat	Beauly		NA	No	No	No	No coloured
49	6	Male	3	1	Yes	June	Colonel	Farrar		5	No	No	No	No coloured
50	9	Male	2	2	No	July	Bobs Tail	Farrar		2	No	No	No	No coloured
51	5	Male	3	1	Yes	July	Lower Ross	Farrar		4	No	No	No	Coloured
52	10	Male	2	2	Yes	July	Culliegrainn	Farrar		3	No	No	No	No coloured
53	3	Male	2	1	Yes	August	Farrar	Farrar	Gate Pool	NA	No	No	No	No coloured
54	6	Male	2	1	Yes	August	NA	NA	AWT Pool	5	No	No	No	Coloured
55	4	Male	2	1	Yes	August	NA	Farrar	Cave Pool	3	No	No	No	No coloured
56	3.5	NA	2	1	Yes	August	NA	Farrar	Gate Pool	4	No	No	No	No coloured
57	5	Female	2	1	Yes	September	Hole in the Hole	Farrar		NA	No	No	No	No coloured
58	5	Male	3	1	Yes	September	Farrar	Farrar		4	No	Yes	No	No coloured
59	3.5	Male	2	1	Yes	September	Farrar	Farrar	Cave Pool	3	No	No	No	No coloured
60	4	Male	3	1	Yes	September	Farrar	Farrar		NA	No	No	No	No coloured
61	2.5	Male	2	1	Yes	September	Long Cast	Beauly		3	No	No	No	No coloured
62	5	Male	2	1	Yes	September	Neaty Beach	Farrar		4	No	No	No	Coloured
63	5	Female	3	1	Yes	October	NA	Farrar	Cave Pool	4	No	No	No	No coloured
64	5	Female	2	1	Yes	October	Farrar	Farrar		6	No	No	No	No coloured
65	4.3	Female	3	1	Yes	October	NA	Glass	Fir Tree	5	No	No	No	Coloured
66	NA	Female	2	1	Yes	October	NA	Glass	Double Bend	5	No	No	No	No coloured
67	10	Male	3	1	Yes	October	Farrar	Farrar		5	No	No	No	No coloured
68	6	Female	3	1	Yes	October	NA	Glass	Fir Tree	4	No	No	No	Coloured
69	5	Female	2	1	Yes	October	Farrar	Farrar	Pulpit	3	No	No	No	No coloured

2016 Scale Samples

ID	Weight	Sex	Fresh water	Sea	Plus	Month	Beat	System	Site	Erosion	Sea lice	Red Vent	Predation	Condition
1	10	Male	2	2	Yes	NA	Farrar	Farrar	Twin Stones	6	No	No	No	Coloured
2	5	Female	3	1	Yes	NA	Farrar	Farrar	Cave Pool	3	No	No	No	No coloured
3	5	Female	3	1	Yes	NA	Farrar	Farrar		3	No	No	No	No coloured
4	5	Female	2	1	Yes	NA	Farrar	Farrar	Cave Pool	4	No	No	No	No coloured
5	6	Female	2	1	Yes	NA	Farrar	Farrar		6	No	No	No	No coloured
6	10	Male	3	1	Yes	NA	Farrar	Farrar	Gate Pool	5	No	No	No	No coloured
7	4	NA	3	1	Yes	NA	NA	NA		4	No	No	No	No coloured
8	6	Male	2	1	Yes	NA	Farrar	Farrar	Cave Pool	4	No	No	No	Coloured
9	6	Male	NA	1	Yes	NA	Farrar	Farrar		4	No	Yes	No	No coloured
10	0	NA	2	1	Yes	NA	NA	NA		NA	No	No	No	No coloured
11	5	Female	3	1	Yes	NA	Farrar	Farrar		5	No	No	No	No coloured
12	8	NA	2	2	Yes	March	Falls	Beauly	Ferry	6	Yes	No	No	No coloured
13	9	Female	2	2	No	April	NA	Beauly	Glide	NA	No	No	No	No coloured
14	10	Male	2	2	No	April	NA	Beauly	Ferry	NA	Yes	No	No	No coloured
15	11	Female	2	2	Yes	May	NA	Beauly	Ferry	NA	Yes	No	Yes	No coloured
16	11	Male	2	2	Yes	May	NA	Beauly	Stones	NA	Yes	No	Yes	No coloured
17	15	Female	3	2	Yes	May	NA	Beauly	Stones	NA	Yes	No	No	No coloured
18	10	NA	2	2	Yes	June	Island Run	Beauly		NA	No	No	No	No coloured
19	10	Female	2	2	Yes	June	Falls	Beauly	Ferry	NA	No	No	Yes	No coloured
20	9	NA	2	2	Yes	June	NA	Beauly	Stones	NA	No	No	No	No coloured
21	4	Female	NA	NA	NA	July	Falls	Beauly	Stones	NA	No	Yes	No	No coloured
22	6	Female	3	1	Yes	July	Falls	Beauly	Beauly	NA	No	No	No	No coloured
23	5	Female	3	1	Yes	July	NA	Beauly	Stones	NA	No	Yes	No	No coloured
24	0	Female	2	1	Yes	July	Falls	Beauly	Stones	NA	Yes	No	No	No coloured
25	4	Female	2	1	Yes	July	NA	Beauly	Ferry	NA	No	Yes	No	No coloured
26	5	Male	2	1	Yes	July	NA	Beauly	Ferry	NA	Yes	No	No	No coloured
27	3.5	Male	3	1	Yes	July	Farrar	Farrar		4	No	No	No	No coloured
28	4	Male	3	1	Yes	July	Green Stream	Farrar		4	No	No	No	No coloured
29	4	Male	2	1	Yes	August	Farrar	Farrar	Road Pool	4	No	No	No	Coloured
30	4	Female	3	1	Yes	August	Farrar	Farrar	Gate Pool	4	No	No	No	No coloured
31	5	Male	2	1	Yes	August	Farrar	Farrar	Bobs Tail	4	No	No	No	Coloured
32	10	Female	2	2	Yes	August	Farrar	Farrar	Road Pool	5	No	No	No	No coloured
33	5	Male	2	1	Yes	August	Farrar	Farrar	Bobs Tail	4	No	No	No	No coloured
34	3	Male	2	1	Yes	August	Green Stream	Farrar		4	No	No	No	No coloured
35	2	Female	2	1	Yes	September	Farrar	Farrar	Bobs Tail	3	No	No	No	No coloured
36	4	Male	2	1	Yes	September	Hole in the wall	Farrar	Hole in the wall	3	No	No	No	No coloured
37	3	Female	3	1	Yes	September	Green Stream	Farrar		3	No	No	No	No coloured
38	4	Male	3	1	Yes	September	Farrar	Farrar	Bobs Tail	6	No	No	No	Coloured
39	4	Male	2	1	Yes	September	Farrar	Farrar	Bobs Tail	4	No	No	No	No coloured
40	6	Female	2	1	Yes	September	NA	Beauly	New Run	5	No	No	No	No coloured
41	3	Male	3	1	Yes	September	NA	Beauly	New Run	3	No	No	No	No coloured

42	3	Male	2	1	Yes	NA	Farrar	Farrar	lawn Row	NA	No	No	No	No coloured
43	4	Male	2	1	Yes	NA	Farrar	Farrar		NA	No	No	No	No coloured
44	6	NA	3	1	Yes	NA	Farrar	Farrar		3	No	No	No	No coloured
45	9	Male	2	1	Yes	NA	Farrar	Farrar	Otter Pool	4	No	No	No	No coloured

2017 Scale Samples

ID	Weight	Sex	Fresh water	Sea	Plus	Month	Beat	System	Site	Erosion	Sea lice	Red Vent	Predation	Condition
1	11	Male	2	2	No	March	NA	Beauly	Glide	NA	No	No	No	No coloured
2	12	Male	2	2	No	March	NA	Beauly	Glide	NA	No	No	No	No coloured
3	9	Male	NA	2	No	April	Falls	Beauly		NA	No	No	No	No coloured
4	8	NA	3	2	No	April	Falls	Beauly		NA	No	No	No	No coloured
5	10	Male	3	2	No	May	Falls	Beauly	Stones	NA	No	No	No	No coloured
6	10	Female	2	2	Yes	May	Falls	Beauly		NA	Yes	No	No	No coloured
7	9	Female	NA	2	No	May	Falls	Beauly	Stones	NA	No	No	No	No coloured
8	13	Male	2	2	No	May	Falls	Beauly	Glide	NA	No	No	No	No coloured
9	9	Female	2	2	No	May	Falls	Beauly	Stones	NA	No	No	No	No coloured
10	14	Female	2	2	No	May	Falls	Beauly	Ferry	NA	No	No	No	No coloured
11	10	Female	2	2	Yes	May	Falls	Beauly	Ferry	NA	No	No	No	No coloured
12	11	Female	2	2	Yes	May	Falls	Beauly	Glide	NA	No	No	No	No coloured
13	8	Female	2	2	Yes	May	Falls	Beauly	Ferry	NA	No	No	No	No coloured
14	10	Female	2	2	Yes	May	Falls	Beauly	Ferry	NA	No	No	No	No coloured
15	11	Male	2	2	Yes	May	Falls	Beauly	Ferry	NA	No	No	No	No coloured
16	4	Male	3	1	Yes	June	Falls	Beauly		NA	No	No	No	No coloured
17	12	Male	3	2	No	May	Falls	Beauly		NA	Yes	No	No	No coloured
18	6	Male	3	2	Yes	May	Falls	Beauly		NA	Yes	No	No	No coloured
19	11	Female	2	2	No	May	NA	Beauly	Home	NA	No	No	No	No coloured
20	12	Female	3	2	Yes	May	NA	Beauly	Glide	NA	No	No	No	No coloured
21	9	Female	2	2	Yes	June	Falls	Beauly		NA	No	No	No	No coloured
22	12	Female	2	2	No	June	NA	Beauly	Glide	NA	No	No	No	No coloured
23	8	Female	2	2	No	June	Falls	Beauly	Ferry	NA	No	No	No	No coloured
24	12	Female	2	2	Yes	June	NA	Beauly	Breaches	NA	No	No	No	No coloured
25	13	Female	2	2	Yes	June	NA	Beauly	Ferry	NA	No	No	No	No coloured
26	11	Female	2	2	Yes	June	NA	Beauly	Breaches	NA	No	No	No	No coloured
27	12	Male	3	2	Yes	June	NA	Beauly	Home	NA	Yes	No	No	No coloured
28	15	Female	2	2	Yes	June	NA	Beauly	Breaches	NA	No	No	No	No coloured
29	4	Female	3	1	Yes	June	Falls	Beauly		NA	No	No	No	No coloured
30	7	Male	2	2	No	June	NA	Beauly	Ferry	NA	No	No	No	No coloured
31	6	Male	2	1	Yes	June	Falls	Beauly		NA	No	No	No	No coloured
32	5.5	Female	3	1	Yes	July	NA	Beauly	Ferry	NA	No	No	No	No coloured
33	4.5	Male	2	1	Yes	July	Falls	Beauly		NA	No	No	No	No coloured
34	4.5	Female	NA	1	Yes	July	Falls	Beauly		NA	No	No	No	No coloured
35	4.5	Female	2	1	Yes	July	Lower Beauly	Beauly		NA	No	No	No	No coloured

36	4.1	Male	2	1	Yes	July	BAC	Beauly	Beat 2	NA	Yes	No	No	No coloured
37	6	Female	2	1	Yes	July	NA	Beauly	Glide	NA	No	Yes	No	No coloured
38	5	NA	2	1	Yes	July	Falls	Beauly		NA	No	No	No	No coloured
39	4.3	Male	2	1	Yes	July	NA	Beauly	New Pool	NA	No	No	No	No coloured
40	3	NA	NA	1	Yes	July	NA	Beauly	Downie	NA	No	No	No	No coloured
41	4	Female	3	1	Yes	July	NA	Beauly	Stones	NA	No	No	Yes	No coloured
42	4	Female	3	1	Yes	August	Falls	Beauly		NA	No	No	No	No coloured
43	4	Female	2	1	Yes	August	NA	Beauly	Old Sty	NA	No	No	Yes	No coloured
44	6	Female	3	1	Yes	August	NA	Beauly	Home	NA	No	No	No	No coloured
45	5	Female	2	1	Yes	August	Falls	Beauly	Ferry	NA	No	No	Yes	No coloured
46	4	Female	2	1	Yes	August	NA	Beauly	Silver	NA	No	No	No	No coloured
47	4	Female	2	1	Yes	August	NA	Beauly	New Pool	NA	No	Yes	No	No coloured
48	2.5	Female	2	1	Yes	August	Falls	Beauly		NA	No	No	No	No coloured
49	7	Male	NA	1	Yes	August	Falls	Beauly		NA	No	No	No	No coloured
50	4.5	Male	2	1	Yes	August	NA	Beauly	Downie	NA	No	No	No	No coloured
51	4.5	Male	3	1	Yes	August	NA	Beauly	Minister	3	No	No	Yes	No coloured
52	12	Female	3	2	Yes	August	NA	Beauly	Ferry	6	No	Yes	No	No coloured
53	6	Male	2	1	Yes	September	NA	Beauly	Silver	6	No	No	No	No coloured
54	4.5	Male	NA	1	Yes	September	BAC	Beauly	Beat 2	3	No	No	Yes	No coloured
55	12	Female	2	2	Yes	July	Culligrain	Farrar		2	No	No	No	No coloured
56	2.5	Female	3	1	Yes	July	Gate	Farrar		4	No	No	No	No coloured
57	6	Female	2	1	Yes	August	Burchore Beach	Farrar		4	No	No	No	No coloured
58	6	Male	2	2	Yes	August	Tail of Cave	Farrar		6	No	No	No	No coloured
59	5.5	Male	2	1	Yes	August	Farrar	Farrar		4	No	No	No	No coloured
60	3	Male	2	1	Yes	August	Farrar	Farrar		3	No	No	No	No coloured
61	4	Male	3	1	Yes	August	G Stream	Farrar		5	No	No	No	No coloured
62	4	Male	2	1	Yes	August	Neaty Beach	Farrar		4	No	No	No	No coloured
63	5	Male	2	1	Yes	August	Otter	Farrar		3	No	No	No	No coloured
64	12	Female	NA	2	Yes	September	Masons	Farrar		5	No	No	No	No coloured
65	3.5	Female	3	1	Yes	September	Leishmore	Farrar		4	No	Yes	No	No coloured
66	4	Female	3	1	Yes	September	B Beach	Farrar		5	No	Yes	No	No coloured
67	4	Male	2	1	Yes	September	Gate	Farrar		6	No	No	No	Coloured
68	5.3	Female	2	1	Yes	September	Upper Farrar	Farrar		5	No	Yes	No	No coloured
69	4	Female	3	1	Yes	September	Twin Stones	Farrar		6	No	No	No	No coloured
70	7	Female	3	1	Yes	September	Twin Stones	Farrar		5	No	No	No	No coloured
71	5	Female	2	1	Yes	September	Tail of Ross	Farrar		5	No	Yes	No	No coloured
72	3	Female	3	1	Yes	September	At D Bend	Farrar		5	No	Yes	No	No coloured
73	2.5	Female	2	1	Yes	September	At D Bend	Farrar		4	No	Yes	No	No coloured
74	6	Male	2	1	Yes	September	Mill Stream	Farrar		6	No	Yes	No	No coloured
75	3	Male	NA	NA	NA	September	Neaty	Farrar		NA	No	No	No	No coloured
76	4	Male	2	1	Yes	September	Neaty	Farrar		5	No	No	No	No coloured
77	3	Female	2	1	Yes	NA	Winters	Farrar		5	No	No	No	No coloured
78	4	Female	3	1	Yes	NA	Farrar	Farrar		4	No	No	No	No coloured
79	2	Male	2	1	Yes	September	Mill Stream	Farrar		6	No	No	No	Coloured

80	4	Female	3	1	Yes	September	Green Stream	Farrar	4	No	No	No	No coloured
81	2.5	Male	2	1	Yes	NA	Gate	Farrar	4	No	No	No	No coloured
82	3	Female	2	1	Yes	September	Colonel	Farrar	5	No	No	No	No coloured
83	9	Female	3	2	Yes	September	Cave	Farrar	5	No	No	No	Coloured
84	4	Male	2	1	Yes	September	Strachan	Farrar	4	No	No	No	No coloured
85	5	Female	3	1	Yes	September	Lodge Pool	Beauly	4	No	No	No	No coloured
86	4	Female	3	1	Yes	September	At Corner	Farrar	4	No	No	No	No coloured
87	4.5	Female	2	1	Yes	September	Corner Pool	Farrar	5	No	Yes	No	No coloured
88	10	Female	2	2	Yes	September	Bobs Tail	Farrar	6	No	No	No	No coloured
89	NA	Male	3	1	Yes	September	Masons	Farrar	2	No	No	No	No coloured
90	4	Female	2	1	Yes	September	Tail of Cave	Farrar	5	No	Yes	No	No coloured
91	4	Female	2	1	Yes	October	Strachan Pool	Farrar	5	No	No	No	No coloured
92	7	Female	2	2	Yes	September	Mauld Bridge	Glass	5	No	No	No	No coloured
93	5	Male	2	1	Yes	September	Eagle Brae	Glass	4	No	No	No	No coloured
94	9	Female	2	2	Yes	September	Eagle Brae	Glass	6	No	No	No	No coloured
95	3	Female	2	1	Yes	October	Crelevan	Glass	4	No	No	No	No coloured

2018 Scale Samples

ID	Weight	Sex	Freshwater	Sea	Plus	Month	System	Site	Erosion	Sea lice	Red Vent	Predation	Condition
1	1.5	NA	2	1	Yes	March	Beauly	Downie	5	No	No	No	No coloured
2	12	Female	2	2	No	May	Beauly	Glide	NA	No	No	No	No coloured
3	11	Male	2	2	Yes	May	Beauly	Ferry	NA	No	No	No	No coloured
4	11	Male	NA	NA	NA	May	Beauly	Ferry	NA	No	No	No	No coloured
5	9	Male	2	2	Yes	May	Beauly	Ferry	NA	No	No	No	No coloured
6	10	Female	2	2	Yes	May	Beauly	Ferry	NA	No	No	No	No coloured
7	10	Male	2	2	Yes	May	Beauly	Ferry	NA	No	No	No	No coloured
9	12	Female	2	2	Yes	June	Beauly	Ferry	NA	No	No	Yes	No coloured
10	11	Male	2	2	Yes	June	Beauly	Silver	NA	No	No	No	No coloured
11	4	Female	2	1	Yes	July	Beauly	Priest	NA	No	No	No	No coloured
12	4	Female	3	1	Yes	July	Beauly	Glide	NA	No	No	No	No coloured
13	4	Female	3	1	Yes	July	Beauly	Old Jetty	3	No	No	No	No coloured
14	3	Female	2	1	Yes	August	Beauly	Old Jetty	4	No	No	No	No coloured
15	5	Female	3	1	Yes	August	Beauly	Glide	2	No	No	No	No coloured
16	6	Male	2	1	Yes	August	Beauly	Beaches	3	No	No	No	No coloured
17	5	Female	2	1	Yes	August	Beauly	Groam	2	No	No	No	No coloured
18	4	Female	2	1	Yes	August	Beauly	Lodge Pool	NA	No	No	No	No coloured
19	5	Female	NA	NA	NA	September	Beauly	Silver	3	No	No	No	No coloured
20	7	Male	2	1	Yes	September	Farrar	Strachan	4	No	No	No	No coloured
21	4	Female	2	1	Yes	September	Farrar	Strachan	3	No	No	No	No coloured
22	5	Male	2	1	Yes	September	Farrar	Strachan	4	No	No	No	No coloured
23	6	Male	NA	NA	NA	October	Farrar	Strachan	3	No	No	No	No coloured