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## Commissioned Report No. – 1902KJ

# Bladnoch Smolt Report

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# Summary

## Bladnoch Smolt Report

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**Keywords**

Salmon; smolt; Bladnoch; age distribution.

**Background**

Each spring a fyke net is secured across the inflow to Torhouse Trout Farm in the river Bladnoch catchment during the salmon smolt migration. The net is emptied daily and any caught fish released back to the river. Atlantic salmon smolts from the net were then sampled once a week taking lengths and scale samples. The scale samples were read to give an age in years which can then be used to compare to previous years and analyse changes in trends.

**Main findings**

- Temperature had a more significant effect (p=0.0012) on the number of smolts than rainfall (p=0.011).
- 92% of Atlantic salmon smolts in this study were two years old.
- There was a significant increase in average lengths between smolts aged one and two years old (p=0.01) but no significant difference in lengths of smolts aged two and three years old (p=0.17).
- 32.8% of two year old smolts were larger than all three year old smolts.

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## 1. INTRODUCTION

Atlantic salmon (*Salmo salar*) are an anadromous species meaning they spend part of their life cycle in freshwater and part in salt water. They begin their life hatching from eggs that are laid in gravel redds, which are created by the female salmon flapping her tail back and forth which sucks up the gravel and creates a depression. The female then deposits her eggs into the redd which are then fertilised by the male. The eggs hatch as alevin which feed on a yolk sac attached to their bodies until it has been completely absorbed after which they emerge from the gravel as fry. Salmon fry feed on small invertebrates for about one year before they develop into parr with distinctive 'thumb prints' along their bodies. Parr reside in the river for one to three years before undergoing physiological changes through a process called smoltification before migrating to sea. During smoltification, the fish move downstream to estuaries where they will gradually gain tolerance to the salt water. Their bodies change shape and colour as they lose their parr marks in favour of a silvery colouration for camouflage in the open sea. They tolerate salt water through reorganisation of the major osmoregulation organs and have increased sodium-potassium pump (Na+/K+-ATPase) activity in their gills (Solomon, Dalhoff and Van Der Kraak, 2013). Smoltification begins in spring and is temperature and rainfall dependent with the main smolt run beginning when river temperatures exceed 8°C. This means Southern areas will see a smolt run earlier than Northern areas (Hvidsten, Heggberget and Jensen, 1998). In the Bladnoch catchment smolts usually begin to appear at the end of March and have mostly migrated out to sea by the end of May or early June. Smolts migrate to sea in shoals and change their diets to small marine fish and amphipods. They grow into adult salmon and after one to four years at sea they return to their natal river to spawn. They use imprints on smells and chemical composition of the water to find their way home while using the Earth's magnetic field as a compass (Scanlan et al., 2018). This allows them to migrate thousands of miles and return to their natal river. Once they have returned to their home river, the fish stop eating and rely on fat stores for energy. The males develop a bright red colour to attract females for spawning. Once spawned, most salmon die however some females can survive and return to sea as kelts before reconditioning and returning to spawn again the following year.

The ages of salmon are determined by growth rings on their scales which can be read by trained professionals to give their age in years. As parr undergo smoltification between one to three years, smolts will be within this age range. The ages can be compared to their lengths to give an estimation of growth rates within the river and the likelihood of survivability at sea. Early smoltification may reduce the chances of survival at sea through increased vulnerability to predation and competition due to their smaller size. Research suggests there is particularly high levels of predation on smolts especially within estuaries. Early smoltification can be onset by increased river temperatures which will be driven by climate change. The changes in both freshwater and marine environments may create a mismatch in feeding times and negatively affect salmon migrating to sea (Thorstad et al., 2012).

Increased early smolting i.e. younger smolts of smaller size will also give negative effects due to the increased vulnerability from predation. Atlantic salmon numbers have been decreasing rapidly since the 18$^{th}$ century due to human impacts such as overfishing, barriers, habitat destruction and pollution. Climate change is expected to continue increasing the water temperatures across the globe and will continue adding extra stresses onto the species. The Bladnoch catchment is popular for salmon fishing and the declines in numbers will also affect tourism. This study will help highlight any issues with early smoltification and can be applied to future studies. A fyke net was used to capture Atlantic salmon smolts entering Torhouse Trout Farm intake in Wigtownshire. Fyke nets are cylindrical fish traps with cone-shaped netting bags mounted on rings. The fish enter voluntarily through wings that guide the fish to the entrance but cannot leave the net again. Fyke nets are secured to the bottom of the river by anchors or stakes. The net is emptied a

minimum of once a day. The fyke net for this study was put in on 24th March 2019 and removed on 4th June 2019. The net is put in annually to ensure migrating smolts do not become trapped in the fish farm intake lade as they move downstream.

## 2. METHODOLOGY

### 2.1 Fyke net

A fyke net was secured over the inflow to Torhouse Trout Farm from 24th March 2019 to 4th June 2019. The end piece of the fyke net had 10 mm mesh and was 3.4 m long with an 80 cm circumference (see photo 1). The main section had 15 mm mesh with 9 rings spaced 70 cm apart with a total length of 5.6 m. The first ring was 90 cm in diameter and the last was 40 cm (see photo 2). The winged sections had 15 mm mesh and extended 6 m to the sides from the centre of the net (see photo 3). The net was placed and managed by Torhouse Trout Farm staff. The net was emptied daily and the total counts of each species present were recorded by Torhouse Trout Farm staff before being released into the river. The only exception was days when Galloway Fisheries Trust (GFT) sampled the catches. On sampling days the fish were transported to tanks in the GFT hatchery which is located at Torhouse Trout Farm. The daily catches were emptied into buckets filled with water for sampling before being released into the main river body downstream of the lade entrance.

Photo 1 – End piece of fyke net

Photo 2 – Main section of fyke net

Photo 3 – Wings of fyke net

### 2.2 Sampling

Once a week GFT sampled the catches from the fyke net. Three buckets were filled with water with an extra bucket designated to anaesthetic. Fish were caught with hand nets from the tanks and placed into a bucket filled with water. Fish were placed into the anaesthetic in small numbers (~5 at a time) until they were calm enough to measure. Lengths were taken from all fish using measuring boards and a scale sample was taken from every 3rd fish taking care not to damage the fish (see photo 4). The fish were then placed in a recovery bucket and given time to recover before being released back into the main river. On days where there was a large number of fish the process was done in steps with buckets of fish being released often to ensure the fish welfare was maintained (see photo 5). Other species present were only counted before being released. Any visible predation damage was noted however this only began in the second half of the project and was not recorded in the first half (see photos 6 and 7). The scale samples were sent away to a professional for reading and age determination.

Photo 4 – Salmon smolt on a measuring board

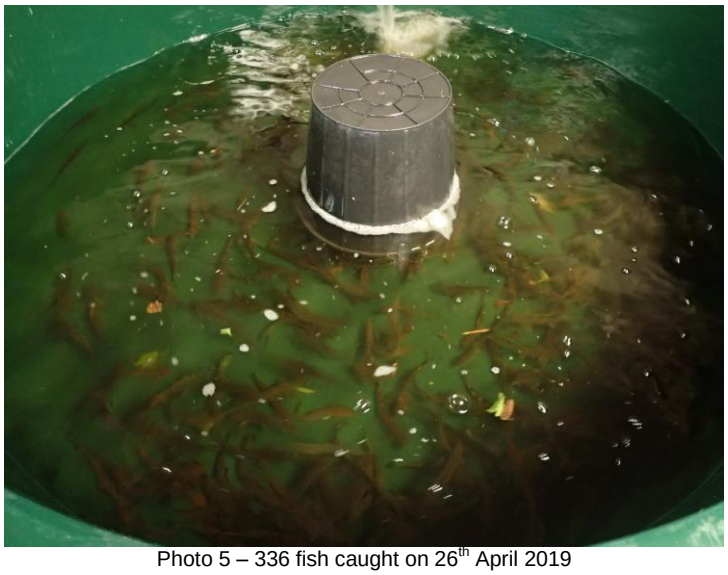


Photo 5 – 336 fish caught on 26th April 2019


Photos 6 and 7 – Smolts showing predation damage on their side

## 3. RESULTS

### 3.1 Fyke net

*3.1.1 Total catches*

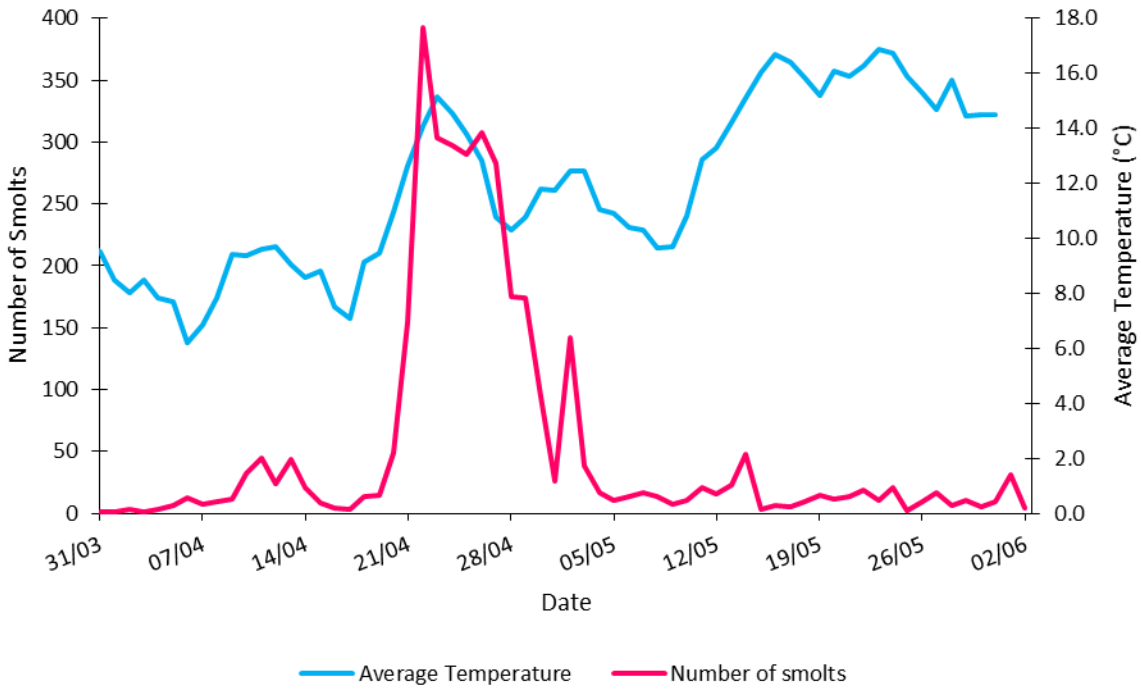
The total catches from the fyke net this year are presented in Table 1. The complete data set can be found in Appendix 1. The fyke net only captures fish entering the fish farm intake lade and does not record any smolts that migrate past the farm in the main river.

*Table 1: Total number of each species caught in the fyke net in 2019*

| Salmon Smolts | Salmon Parr | Brown Trout | Roach | Perch | River Lamprey | Pike | Eel |
|---|---|---|---|---|---|---|---|
| 3466 | 155 | 161 | 52 | 2 | 12 | 3 | 1 |

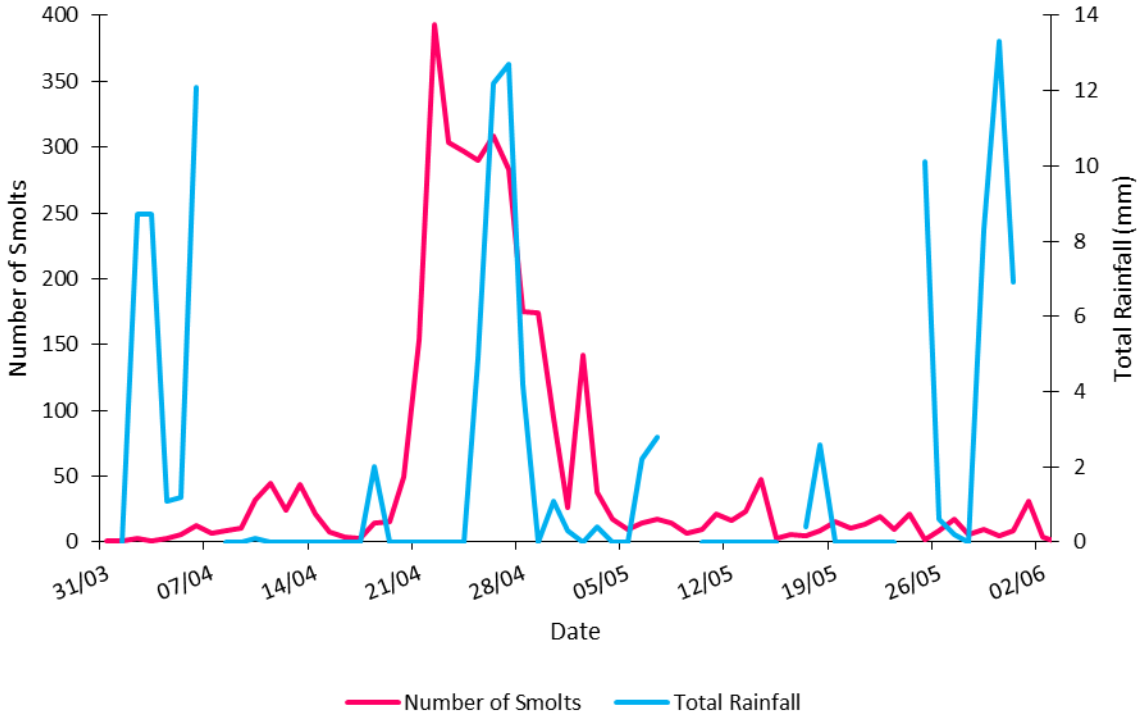
*3.1.2 Temperature and rainfall*

Graph 1 presents the total number of smolts per day against average daily temperature while Graph 2 presents the total number of smolts against the total rainfall for each day. The first smolts appeared on 29th March and the last day there were smolts in the net was 2nd June. The main smolt run occurred between 19th April and 3rd May after temperatures passed 8°C on 18th April. During this period there were 2742 smolts caught in the net which was 79.1% of the total number of smolts (3466) that passed through the net. From the graphs it would appear temperature had a greater effect on the number of smolts than rainfall during the main run. Regression analysis confirmed that temperature (p=0.0012) had a more significant effect than rainfall (p=0.011) during the main smolt run although rainfall still had a significant effect.




*Graph 1: The daily smolt count with average daily temperatures from 31st March to 2nd June 2019. The first smolts appeared on 29th March however there was no data record for 30th*

*March therefore the data starts on 31st March. The red line represents the daily smolt count while the blue line represents average daily temperature.*



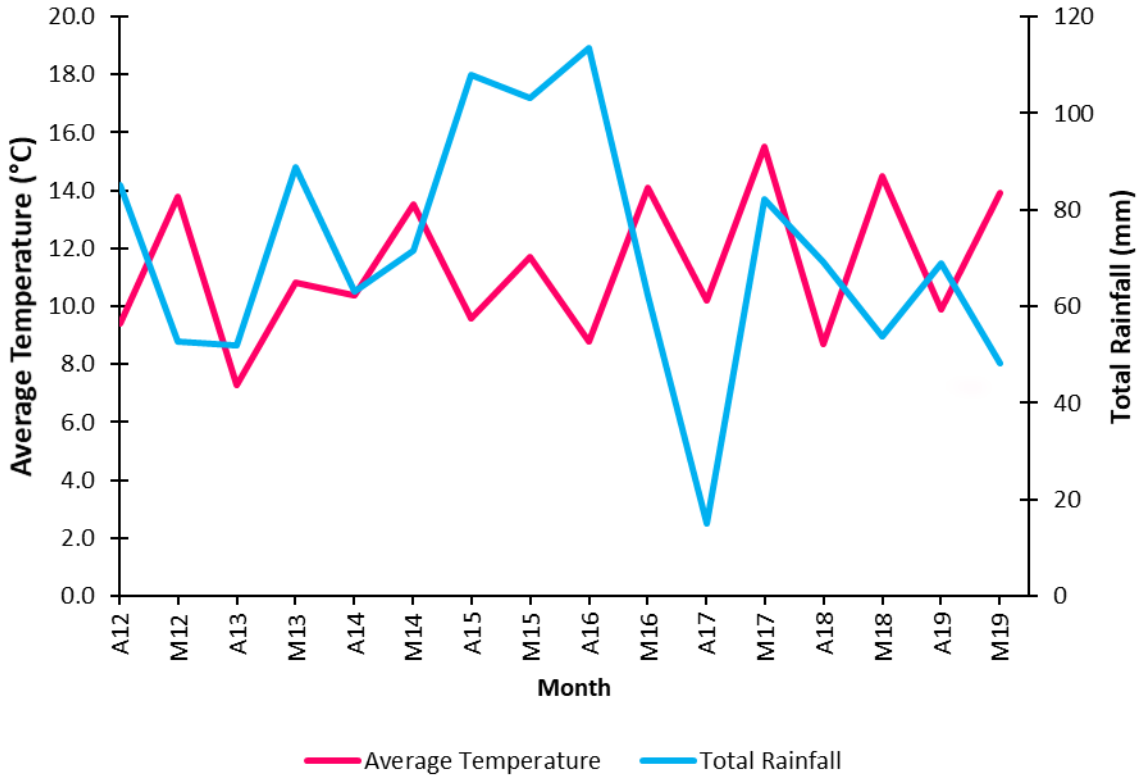

*Graph 2: The daily smolt counts and the total rainfall per day from 31st March to 2nd June 2019. The first smolts appeared on 29th March however there was no record for 30th March therefore the data starts on 31st March. There are several gaps in rainfall data as there were several days where there was no rainfall. The red line represents the daily smolt count while the blue line represents average daily temperature.*

### *3.1.3 Data from previous years*

The fyke net has been used to collect count data since 2010 which allows comparisons of catches between years. It is important to remember the net only catches a proportion of the smolts run which will be expected to vary depending on overall river flows. Table 2 presents the total number of catches of each species from 2010-2019. Graph 3 presents the average temperature and total rainfall for April and May each year from 2012-2019. There was no temperature or rainfall data before 2012. This year's total catches ranked 4th since 2010 behind 2017 (4717), 2015 (4003), and 2011 (3153). The lowest number of smolts ever caught was in 2013 (1269) when the average lowest temperature occurred during April.

*Table 2 – Total number of each species caught 2010-2019*

| Year | Smolts | Salmon Parr | Brown Trout | Rudd/ Roach | Perch | River Lamprey | Pike | Eel |
|---|---|---|---|---|---|---|---|---|
| 2010 | 1827 | 40 | 46 | 128 | 0 | 34 | 6 | 12 |
| 2011 | 3153 | 172 | 31 | 20 | 0 | 16 | 0 | 1 |
| 2012 | 1984 | 242 | 92 | 8 | 1 | 32 | 1 | 8 |
| 2013 | 1269 | 305 | 65 | 126 | 0 | 6 | 1 | 5 |
| 2012 | 2076 | 190 | 56 | 86 | 1 | 12 | 2 | 11 |
| 2015 | 4003 | 79 | 32 | 47 | 1 | 16 | 0 | 10 |
| 2016 | 2753 | 107 | 87 | 19 | 2 | 42 | 3 | 1 |
| 2017 | 4717 | 187 | 99 | 8 | 0 | 8 | 2 | 5 |
| 2018 | 1721 | 134 | 56 | 12 | 0 | 29 | 0 | 6 |
| 2019 | 3466 | 155 | 161 | 52 | 2 | 12 | 3 | 1 |




*Graph 3: The average temperatures and total rainfall during the months of April and May from 2012-2019. On the x axis, A represents April and M represents May. The number represent the year. The highest total rainfall was recorded during April 2016 and the lowest in April 2017. The highest average temperatures were in May 2017 and the lowest were in April 2013.*

## 3.2 Sampling in 2019

### *3.2.1 Length sampling*

The total number of smolts sampled in 2019 was 221 with 74 scale samples taken. This means that 6.3% of the total number of smolts that were caught in the fyke net were sampled. The overall average length was 132.6 ± 11.3 mm. The shortest length was 104 mm and the greatest length was 166 mm. All sampling data is presented in Appendix 2.

### *3.2.2 Predation damage*

From 19th April onwards any noticeable predator damage was noted. During sampling from 19th April – 23rd May 2019 there were 16 smolts with noticeable predator damage which is 7.2% of smolts sampled during this period. This was not tested sufficiently so it can be assumed that the number was much higher. The lengths of damaged smolts varied from 119 – 156 mm indicating vulnerability was not dependant on size.

## 3.3 Age data

### *3.3.1 Total number of smolts in each age group*

All scale samples collected were read to give an age in years of each smolt. Seventy three scales were read (one sample did not have any scales that were readable). All age data is presented in Appendix 3. Age groups are represented as a number in years and are categorised into years 1, 2, and 3. Table 3 presents the number of smolts within each age group and the percentage of smolts each group represented.

*Table 3: Number of smolts in each age group*

| Age Group | Total Number of Smolts | % Represented |
|---|---|---|
| 1 | 3 | 4 |
| 2 | 67 | 92 |
| 3 | 3 | 4 |

The age group 2 years old represented 92% of all smolts in this study and also had the highest variation in length. The age groups 1 and 3 both represented 4% of smolts. These percentages coincide with previous years which can be seen in Table 4 which presents data from scale samples taken at Torhouse Trout Farm.

*Table 4: Percentages of smolts ages from previous years*

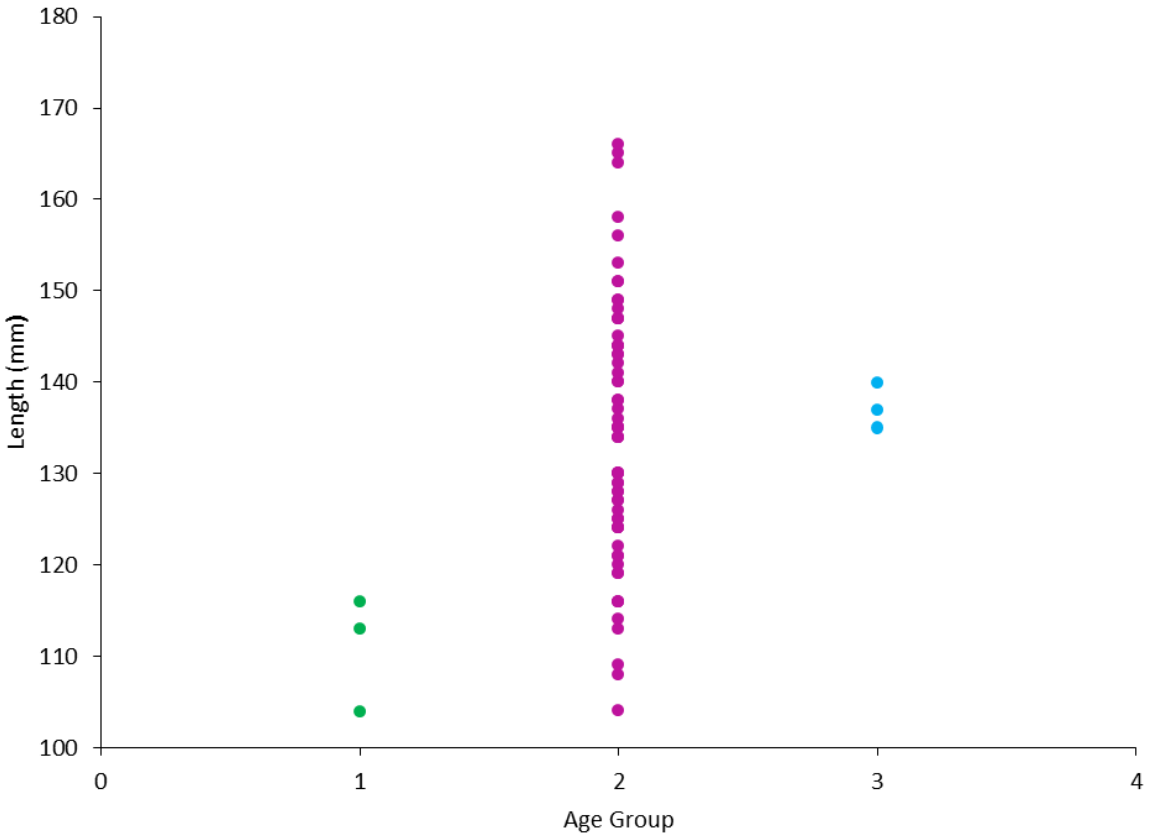
| Year | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **2001** | 16.5% | 82.9% | 0.6% | |
| **2002** | 9.6% | 89.3% | 1.1% | |
| **2004** | 6.8% | 69.2% | 23.7% | 0.3% |
| **2007** | 20.1% | 79.2% | 0.7% | |
| **2008** | 22.4% | 77% | 0.6% | |
| **2013** | 0.8% | 92.5% | 6.7% | |

Each year scale samples have been taken 2 year old smolts represent the vast majority indicating that most Atlantic salmon in the river Bladnoch undergo smoltification after they reach 2 years old. Year 1 smolt percentages have varied but have never represented more

than 23% of all smolts. This variation indicates fluctuations in the environmental characteristics that drive smoltification.

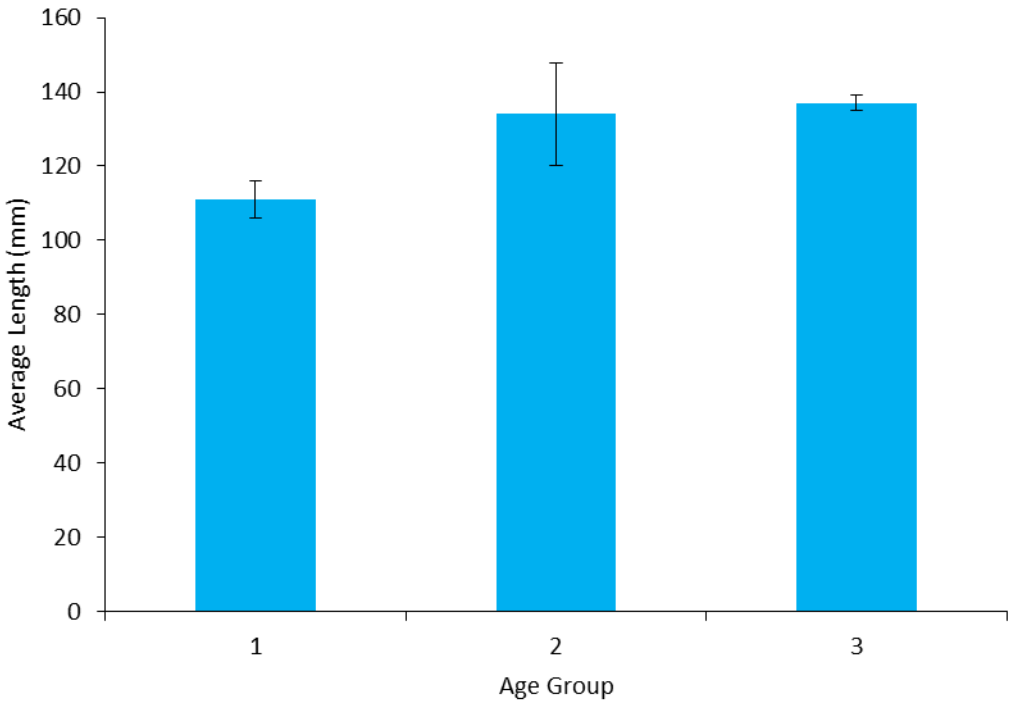
*3.3.2 Lengths of each age group*

The smallest length (104 mm) was represented by the smolt age groups 1 and 2. The highest length from the aged 1 and 3 year smolts was 116 mm and 140 mm respectively. The 22 highest lengths (>140 mm) were represented by the year 2 group. Graph 4 presents the lengths of each individual smolt within each age group. The variation in length for year 2 smolts suggests that individuals came from different areas within the catchment with variations in access to resources.




*Graph 4: All length data within each age group as a scatter graph. The groups represent the age in years of each smolt. Each dot on the scatter graph represent the length of each individual smolt. The green dots represent smolts that are 1 year old, the purple dots represent smolts that are 2 years old, and the blue dots represent smolts that are 3 years old.*

Although year 2 smolts represented the greatest lengths, the overall average lengths appeared to increase with age group. Graph 5 presents the average lengths for each age group with standard deviations. The standard deviations show that although the average lengths increase by age group, some smolts in the aged 2 group were larger than the aged 3 group. Of the aged 2 smolts, 32.8% were larger than all aged 3 smolts. A t-Test showed that there was a significant increase in average length between aged 1 and 2 smolts ($p=0.01$) but no significant increase between aged 2 year old and 3 year old smolts ($p=0.17$). This indicates that the growth rates of the aged 3 smolts have been slower than some 2 year old smolts due to having less access to resources.




*Graph 5: The average lengths of smolts within each age group in mm ± standard deviation. Year 2 smolts represented the largest number of smolts and had the highest variation therefore had the highest standard deviation. 1 and 3 year old smolts both represented only 3 smolts each giving them a lower standard deviation. The average length of year 1 smolts was 111±5.1 mm, year 2 smolts was 134±13.9 mm, and year 3 smolts was 137±2.1 mm.*

# 4. DISCUSSION

## 4.1 Fyke net

The limitations of the fyke net were that it only covered a small area of the river and fish enter voluntarily. The catches only represent a fraction of the total river populations and with sampling only taking place once a week, no definite conclusions can be made. However, the sample size used for this report can still indicate the current status of smolts in the Bladnoch catchment. This year saw the 4$^{th}$ highest total catch number since 2010. The variation between years is linked to differences in temperatures and rainfall but does help to indicate differences in smolt abundance between years. This year's temperatures and rainfall were relatively high compared to previous years. Higher temperatures allow salmon to smolt earlier, giving them more time to migrate to sea while higher rainfall helps push them down the catchment through increased flow.

## 4.2 Sampling and ages

Due to the small sample size in this study, no definitive conclusions can be made. However, the results from the scale readings coincide with previous years that had larger data sets. This suggests that the sample set used in this study can be used to indicate the general ages salmon undergo smoltification within the river Bladnoch. The majority of smolts were within the normal age range suggesting there have been no recent significant changes in smolt ages due to climate change. The lengths of age group 2 were extremely varied which suggests that smolts from different areas of the catchment had different levels of access to resources. The larger smolts likely had good access to food and space while smaller smolts likely had less possibly through increased competition. The smolts represented by aged 3 smolts were not significantly larger than 2 year old smolts. This suggests lack of resources slowed growth rates meaning they had to wait the extra year to smolt. The year 1 smolts were relatively small and may have undergone smoltification due to environmental factors in their original habitat. The smallest smolts will have lower survival rates meaning there were factors at play that caused them to undergo smoltification early. However, no definitive conclusions can be made on this without further information. The limited data on predation damage from 19$^{th}$ April – 23$^{rd}$ May suggested 7.2% were wounded and may not have survived in the long term. Pike are the most likely cause of the predation. In this study it can be assumed there was no relationship between size and vulnerability to predation.

## 5. APPENDIX 1: RESULTS FROM FYKE NET

| Date | T ° (av) | R mm | Parr | Smolts | Brown Trout | Rudd/ Roach | Perch | River Lamprey | Pike | Eel |
|---|---|---|---|---|---|---|---|---|---|---|
| **TOTALS** | | | 155 | 3466 | 161 | 52 | 2 | 12 | 3 | 1 |
| 24/03/2019 | 7.1 | 1.5 | 2 | 1 | 1 | 1 | | | | |
| 25/03/2019 | 7 | 0 | 3 | 2 | 1 | 2 | | | | |
| 26/03/2019 | 8 | tr | 2 | 1 | 1 | 2 | | | | |
| 27/03/2019 | 8 | 0 | 3 | 1 | | 1 | | | | |
| 28/03/2019 | 8.9 | 0 | 4 | 4 | 1 | 1 | | | | |
| 29/03/2019 | 8.8 | 0 | 9 | 6 | | | | 2 | | |
| 30/03/2019 | 9.9 | 0 | 9 | 10 | 2 | 2 | 2 | 1 | | |
| 31/03/2019 | 9.5 | tr | 5 | 8 | 1 | 1 | | | | |
| 01/04/2019 | 8.5 | 0 | 5 | 8 | 1 | 1 | | | | |
| 02/04/2019 | 8 | 8.7 | 4 | 6 | 1 | 1 | | 1 | | |
| 03/04/2019 | 8.5 | 8.7 | 2 | 2 | | | | | | |
| 04/04/2019 | 7.85 | 1.1 | 1 | 3 | 1 | | | | | |
| 05/04/2019 | 7.7 | 1.2 | 1 | 6 | | | | | | |
| 06/04/2019 | 6.2 | 12.1 | 3 | 14 | 1 | | | | | |
| 07/04/2019 | 6.85 | tr | 4 | 10 | 2 | | | | | |
| 08/04/2019 | 7.85 | 0 | 2 | 9 | | | | | | |
| 09/04/2019 | 9.4 | 0 | 4 | 13 | 1 | | | 1 | | |
| 10/04/2019 | 9.35 | 0.1 | 8 | 36 | 2 | | | | | |
| 11/04/2019 | 9.6 | 0 | 8 | 48 | 4 | | | | | |
| 12/04/2019 | 9.7 | 0 | 3 | 36 | 10 | | | 1 | | |
| 13/04/2019 | 9.05 | 0 | 4 | 46 | 5 | | | 1 | | 1 |
| 14/04/2019 | 8.6 | 0 | | 23 | | 1 | | | | |
| 15/04/2019 | 8.8 | 0 | 1 | 8 | | 1 | | 1 | | |
| 16/04/2019 | 7.5 | 0 | | 4 | 1 | | | | | |
| 17/04/2019 | 7.1 | 0 | 1 | 3 | 1 | | | | | |
| 18/04/2019 | 9.15 | 2 | 3 | 14 | | | | | | |
| 19/04/2019 | 9.45 | 0 | 2 | 15 | 3 | | | | | |
| 20/04/2019 | 10.95 | 0 | 1 | 49 | 2 | | | | | |
| 21/04/2019 | 12.65 | 0 | | 154 | 2 | | | 1 | | |
| 22/04/2019 | 14.1 | 0 | 2 | 393 | 1 | | | | | |
| 23/04/2019 | 15.15 | 0 | 4 | 304 | 3 | 2 | | | 1 | |
| 24/04/2019 | 14.55 | 0 | | 297 | 4 | | | | | |
| 25/04/2019 | 13.8 | 4.9 | 4 | 290 | 14 | | | 1 | | |
| 26/04/2019 | 12.8 | 12.2 | | 308 | 28 | | | | | |
| 27/04/2019 | 10.75 | 12.7 | 3 | 283 | 5 | 1 | | | 1 | |
| 28/04/2019 | 10.3 | 4.2 | 4 | 175 | 12 | | | 1 | | |
| 29/04/2019 | 10.75 | 0 | 5 | 174 | 11 | 9 | | | | |
| 30/04/2019 | 11.8 | 1.1 | 2 | 94 | 4 | | | | | |
| 01/05/2019 | 11.75 | 0.3 | 1 | 26 | | 2 | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 02/05/2019 | 12.45 | 0 | 2 | 142 | 3 | | | 1 | | |
| 03/05/2019 | 12.45 | 0.4 | | 38 | 6 | | | | | |
| 04/05/2019 | 11.05 | 0 | | 17 | 7 | 3 | | | | |
| 05/05/2019 | 10.9 | 0 | 2 | 10 | 1 | 1 | | | | |
| 06/05/2019 | 10.4 | 2.2 | 2 | 14 | 3 | | | | | |
| 07/05/2019 | 10.3 | 2.8 | 4 | 17 | 1 | 2 | | | | |
| 08/05/2019 | 9.65 | tr | 3 | 14 | | | | | | |
| 09/05/2019 | 9.7 | tr | | 7 | 2 | | | | | |
| 10/05/2019 | 10.8 | 0 | | 10 | | 1 | | | | |
| 11/05/2019 | 12.85 | 0 | | 21 | | 1 | | | | |
| 12/05/2019 | 13.3 | 0 | | 16 | 1 | 4 | | | | |
| 13/05/2019 | 14.2 | 0 | | 23 | 2 | | | | 1 | |
| 14/05/2019 | 15.1 | 0 | 2 | 48 | 1 | 1 | | | | |
| 15/05/2019 | 16.05 | 0 | | 3 | 1 | | | | | |
| 16/05/2019 | 16.7 | tr | | 6 | | | | | | |
| 17/05/2019 | 16.4 | 0.4 | | 5 | | | | | | |
| 18/05/2019 | 15.85 | 2.6 | | 9 | | | | | | |
| 19/05/2019 | 15.2 | 0 | 2 | 15 | | 1 | | | | |
| 20/05/2019 | 16.1 | 0 | 1 | 11 | | | | | | |
| 21/05/2019 | 15.9 | 0 | 2 | 13 | | 1 | | | | |
| 22/05/2019 | 16.25 | 0 | 1 | 19 | | 2 | | | | |
| 23/05/2019 | 16.9 | 0 | 1 | 10 | | | | | | |
| 24/05/2019 | 16.75 | tr | | 21 | | | | | | |
| 25/05/2019 | 15.9 | 10.1 | | 2 | | | | | | |
| 26/05/2019 | 15.3 | 0.6 | 2 | 9 | | | | | | |
| 27/05/2019 | 14.7 | 0.2 | | 17 | | | | | | |
| 28/05/2019 | 15.75 | 0 | | 6 | | | | | | |
| 29/05/2019 | 14.45 | 8.3 | | 10 | | | | | | |
| 30/05/2019 | 14.5 | 13.3 | | 5 | | | | | | |
| 31/05/2019 | 14.5 | 6.9 | 2 | 9 | | | | | | |
| 01/06/2019 | 13.3 | 7.8 | 5 | 31 | 3 | 3 | | | | |
| 02/06/2019 | 14.25 | 3.2 | 4 | 4 | 3 | 4 | | | | |
| 03/06/2019 | | | 1 | 0 | 1 | | | | | |
| 04/06/2019 | | | | 0 | | | | | | |

## 6. APPENDIX 2: ALL SAMPLING DATA

| Date | Length | Scale Sample |
|---|---|---|
| 05/04/2019 | 145 | 1 |
| 05/04/2019 | 122 | |
| 05/04/2019 | 138 | |
| 05/04/2019 | 147 | 2 |
| 05/04/2019 | 128 | |
| 05/04/2019 | 135 | 3 |
| 12/04/2019 | 130 | |
| 12/04/2019 | 135 | 4 |
| 12/04/2019 | 125 | |
| 12/04/2019 | 157 | |
| 12/04/2019 | 133 | |
| 12/04/2019 | 140 | 5 |
| 12/04/2019 | 122 | |
| 12/04/2019 | 146 | |
| 12/04/2019 | 141 | |
| 12/04/2019 | 119 | |
| 12/04/2019 | 124 | 6 |
| 12/04/2019 | 127 | |
| 12/04/2019 | 140 | 7 |
| 12/04/2019 | 148 | |
| 12/04/2019 | 129 | |
| 12/04/2019 | 141 | |
| 12/04/2019 | 104 | 8 |
| 12/04/2019 | 148 | |
| 12/04/2019 | 117 | |
| 12/04/2019 | 120 | 9 |
| 12/04/2019 | 164 | 10 |
| 12/04/2019 | 147 | 11 |
| 12/04/2019 | 138 | |
| 12/04/2019 | 112 | |
| 12/04/2019 | 158 | 12 |
| 12/04/2019 | 137 | |
| 12/04/2019 | 134 | 13 |
| 12/04/2019 | 145 | |
| 12/04/2019 | 133 | |
| 12/04/2019 | 120 | |
| 12/04/2019 | 130 | 14 |
| 12/04/2019 | 119 | |
| 12/04/2019 | 118 | |
| 12/04/2019 | 129 | 15 |
| 12/04/2019 | 130 | 16 |
| 12/04/2019 | 132 | |
| 19/04/2019 | 145 | |
| 19/04/2019 | 144 | |
| 19/04/2019 | 134 | 17 |
| 19/04/2019 | 156 | |
| 19/04/2019 | 133 | |
| 19/04/2019 | 142 | 18 |
| 19/04/2019 | 139 | |
| 19/04/2019 | 130 | |
| 19/04/2019 | 149 | 19 |
| 19/04/2019 | 145 | |
| 19/04/2019 | 140 | |
| 19/04/2019 | 137 | |
| 19/04/2019 | 128 | 20 |
| 19/04/2019 | 147 | |
| 19/04/2019 | 126 | |
| 19/04/2019 | 134 | 21 |
| 26/04/2019 | 120 | |
| 26/04/2019 | 125 | |
| 26/04/2019 | 137 | 22 |
| 26/04/2019 | 134 | |
| 26/04/2019 | 138 | |
| 26/04/2019 | 124 | 23 |
| 26/04/2019 | 119 | |
| 26/04/2019 | 120 | |
| 26/04/2019 | 130 | 24 |
| 26/04/2019 | 140 | |
| 26/04/2019 | 135 | |
| 26/04/2019 | 113 | 25 |
| 26/04/2019 | 141 | |
| 26/04/2019 | 134 | |
| 26/04/2019 | 130 | 26 |
| 26/04/2019 | 127 | |
| 26/04/2019 | 136 | |
| 26/04/2019 | 114 | 27 |
| 26/04/2019 | 140 | |
| 26/04/2019 | 132 | |
| 26/04/2019 | 125 | 28 |
| 26/04/2019 | 131 | |
| 26/04/2019 | 134 | |
| 26/04/2019 | 127 | 29 |
| 26/04/2019 | 133 | |
| 26/04/2019 | 109 | |

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|---|---|---|
| 26/04/2019 | 143 | 30 |
| 26/04/2019 | 130 | |
| 26/04/2019 | 122 | |
| 26/04/2019 | 128 | |
| 26/04/2019 | 144 | 31 |
| 26/04/2019 | 129 | |
| 26/04/2019 | 129 | |
| 26/04/2019 | 143 | 32 |
| 26/04/2019 | 136 | |
| 26/04/2019 | 127 | |
| 26/04/2019 | 116 | 33 |
| 26/04/2019 | 120 | |
| 26/04/2019 | 123 | |
| 26/04/2019 | 135 | 34 |
| 26/04/2019 | 125 | |
| 26/04/2019 | 122 | |
| 26/04/2019 | 121 | 35 |
| 26/04/2019 | 117 | |
| 26/04/2019 | 131 | |
| 26/04/2019 | 125 | 36 |
| 26/04/2019 | 126 | |
| 26/04/2019 | 131 | |
| 26/04/2019 | 136 | |
| 26/04/2019 | 140 | 37 |
| 26/04/2019 | 136 | |
| 26/04/2019 | 131 | |
| 26/04/2019 | 156 | 38 |
| 26/04/2019 | 124 | |
| 26/04/2019 | 136 | |
| 26/04/2019 | 123 | |
| 26/04/2019 | 119 | 39 |
| 26/04/2019 | 137 | |
| 26/04/2019 | 129 | |
| 26/04/2019 | 146 | 40 |
| 26/04/2019 | 133 | |
| 26/04/2019 | 135 | |
| 26/04/2019 | 116 | 41 |
| 26/04/2019 | 144 | |
| 26/04/2019 | 131 | |
| 26/04/2019 | 138 | 42 |
| 26/04/2019 | 131 | |
| 26/04/2019 | 125 | |
| 26/04/2019 | 135 | 43 |
| 26/04/2019 | 140 | |

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|---|---|---|
| 26/04/2019 | 124 | |
| 26/04/2019 | 135 | 44 |
| 26/04/2019 | 122 | |
| 26/04/2019 | 143 | |
| 26/04/2019 | 122 | 45 |
| 26/04/2019 | 139 | |
| 26/04/2019 | 146 | |
| 26/04/2019 | 141 | 46 |
| 26/04/2019 | 134 | |
| 26/04/2019 | 127 | |
| 26/04/2019 | 121 | 47 |
| 26/04/2019 | 134 | |
| 26/04/2019 | 126 | |
| 26/04/2019 | 149 | 48 |
| 26/04/2019 | 134 | |
| 26/04/2019 | 132 | |
| 26/04/2019 | 109 | 49 |
| 26/04/2019 | 127 | |
| 26/04/2019 | 134 | |
| 26/04/2019 | 119 | 50 |
| 26/04/2019 | 146 | |
| 26/04/2019 | 128 | |
| 26/04/2019 | 137 | 51 |
| 26/04/2019 | 126 | |
| 26/04/2019 | 144 | |
| 26/04/2019 | 108 | 52 |
| 26/04/2019 | 114 | |
| 26/04/2019 | 144 | |
| 26/04/2019 | 144 | 53 |
| 26/04/2019 | 122 | |
| 26/04/2019 | | |
| 03/05/2019 | 136 | |
| 03/05/2019 | 119 | |
| 03/05/2019 | 138 | 54 |
| 03/05/2019 | 126 | |
| 03/05/2019 | 137 | |
| 03/05/2019 | 136 | 55 |
| 03/05/2019 | 143 | |
| 03/05/2019 | 126 | |
| 03/05/2019 | 128 | 56 |
| 03/05/2019 | 127 | |
| 03/05/2019 | 148 | |
| 03/05/2019 | 153 | 57 |
| 03/05/2019 | 127 | |

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|---|---|---|
| 03/05/2019 | 122 | |
| 03/05/2019 | 135 | 58 |
| 03/05/2019 | 139 | |
| 03/05/2019 | 137 | |
| 03/05/2019 | 124 | 59 |
| 03/05/2019 | 135 | |
| 03/05/2019 | 130 | |
| 03/05/2019 | 147 | 60 |
| 03/05/2019 | 147 | |
| 03/05/2019 | 138 | |
| 03/05/2019 | 104 | 61 |
| 03/05/2019 | 126 | |
| 03/05/2019 | 134 | |
| 03/05/2019 | 144 | 62 |
| 03/05/2019 | 136 | |
| 03/05/2019 | 125 | |
| 03/05/2019 | 116 | 63 |
| 03/05/2019 | 122 | |
| 03/05/2019 | 126 | |
| 03/05/2019 | 165 | 64 |
| 03/05/2019 | 156 | |
| 03/05/2019 | 127 | |
| 03/05/2019 | 129 | 65 |
| 03/05/2019 | 129 | |
| 03/05/2019 | 133 | |

| | | |
|---|---|---|
| 10/05/2019 | 118 | |
| 10/05/2019 | 154 | |
| 10/05/2019 | 116 | 66 |
| 10/05/2019 | 133 | |
| 10/05/2019 | 119 | |
| 10/05/2019 | 124 | 67 |
| 10/05/2019 | 139 | |
| 10/05/2019 | 118 | |
| 10/05/2019 | 151 | 68 |
| 10/05/2019 | 105 | |
| 17/05/2019 | 131 | |
| 17/05/2019 | 113 | 69 |
| 17/05/2019 | 138 | |
| 17/05/2019 | 126 | 70 |
| 17/05/2019 | 127 | 71 |
| 23/05/2019 | 134 | |
| 23/05/2019 | 142 | |
| 23/05/2019 | 148 | 72 |
| 23/05/2019 | 136 | |
| 23/05/2019 | 146 | |
| 23/05/2019 | 166 | 73 |
| 23/05/2019 | 144 | |
| 23/05/2019 | 139 | |
| 23/05/2019 | 151 | 74 |
| 23/05/2019 | 134 | |

## 7. APPENDIX 3: ALL AGE DATA

| Age | Length |
|---|---|
| -1 | 146 |
| 1 | 104 |
| 1 | 116 |
| 1 | 113 |
| 2 | 145 |
| 2 | 147 |
| 2 | 135 |
| 2 | 135 |
| 2 | 124 |
| 2 | 140 |
| 2 | 104 |
| 2 | 120 |
| 2 | 164 |
| 2 | 147 |
| 2 | 158 |
| 2 | 134 |
| 2 | 130 |
| 2 | 129 |
| 2 | 130 |
| 2 | 134 |
| 2 | 142 |
| 2 | 149 |
| 2 | 128 |
| 2 | 134 |
| 2 | 124 |
| 2 | 130 |
| 2 | 113 |
| 2 | 130 |
| 2 | 114 |
| 2 | 125 |
| 2 | 127 |
| 2 | 143 |
| 2 | 144 |
| 2 | 143 |
| 2 | 116 |
| 2 | 121 |
| 2 | 125 |
| 2 | 140 |
| 2 | 156 |
| 2 | 119 |
| 2 | 116 |
| 2 | 138 |
| 2 | 135 |
| 2 | 135 |
| 2 | 122 |
| 2 | 141 |
| 2 | 121 |
| 2 | 149 |
| 2 | 109 |
| 2 | 119 |
| 2 | 137 |
| 2 | 108 |
| 2 | 144 |
| 2 | 138 |
| 2 | 136 |
| 2 | 128 |
| 2 | 153 |
| 2 | 135 |
| 2 | 124 |
| 2 | 147 |
| 2 | 144 |
| 2 | 165 |
| 2 | 129 |
| 2 | 116 |
| 2 | 124 |
| 2 | 151 |
| 2 | 126 |
| 2 | 127 |
| 2 | 148 |
| 2 | 166 |
| 2 | 151 |
| 3 | 140 |
| 3 | 137 |
| 3 | 135 |

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