

# WILD ATLANTIC SALMON CONSERVATION

## Collapse of the River Carron







**UHI | INVERNESS**  
**Professor Melanie Smith**



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## Conservation Management Principles

- Research and knowledge exchange
- Establishment of the baseline
- Programme of Monitoring
- Rigorous protocol
- Cycle of review and reporting
- Communication and engagement

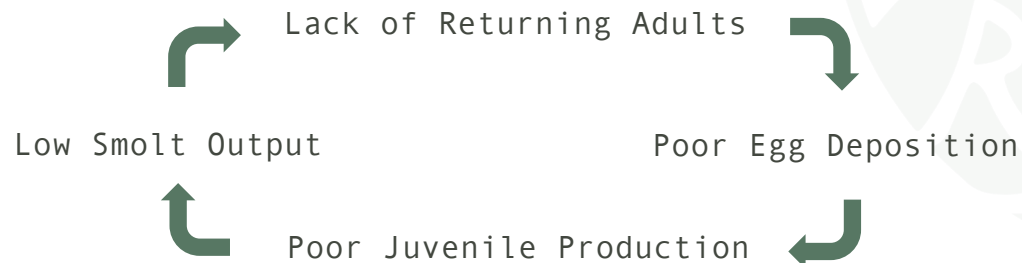
# WILD ATLANTIC SALMON CONSERVATION

## Collapse of the River Carron

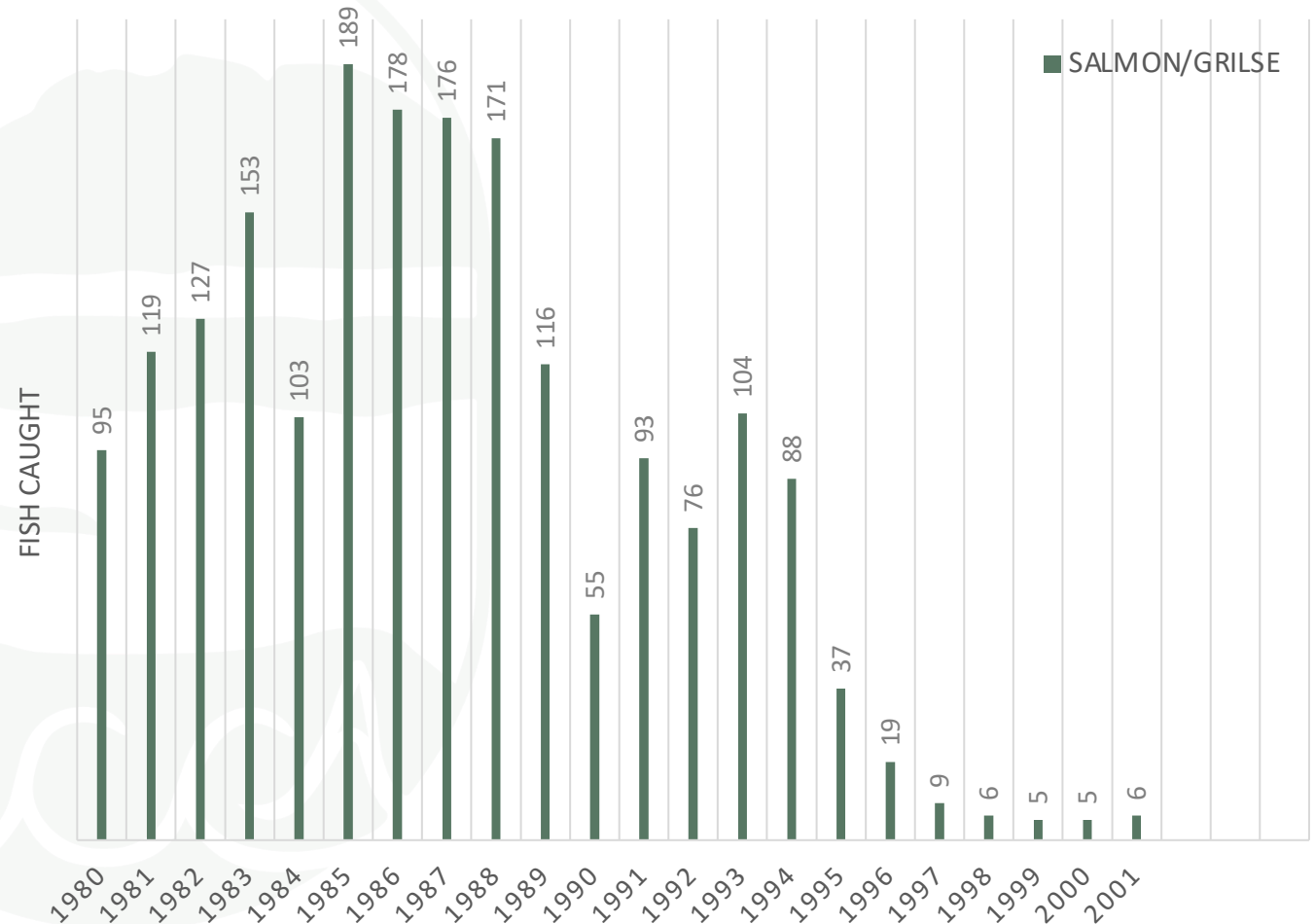
Rod catches of salmon and sea trout on the river collapsed through the 1990's. Was this collapse caused by winter spates?

Maximum flows in  $m^3s^{-1}$

1988/89 - 337  
1989/90 - 202  
1990/91 - 213  
1991/92 - 178  
1992/93 - 253  
1998/99 - 120  
2006/07 - 233



### CARRON CATCH STATS SALMON/GRILSE





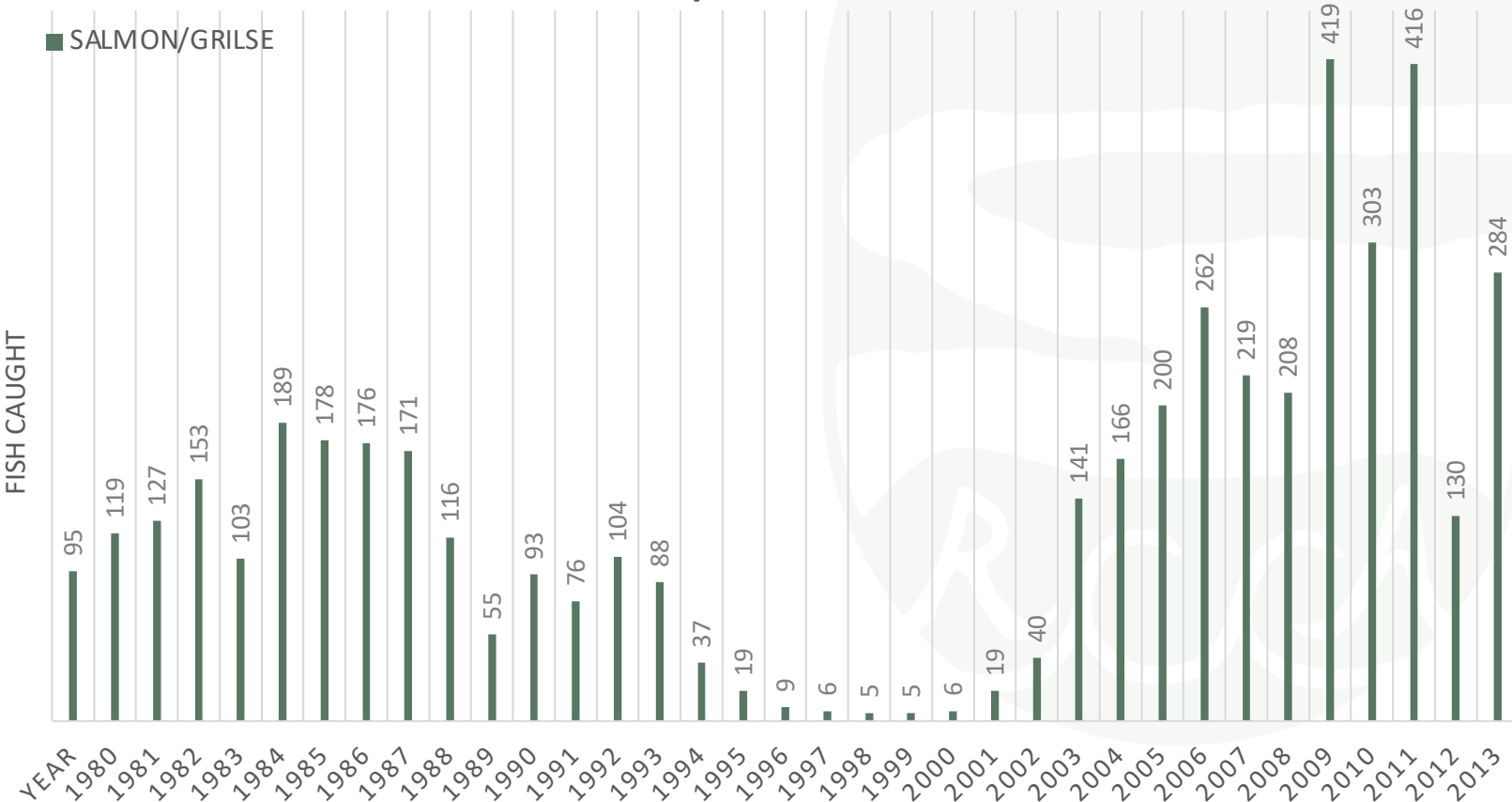
# WILD ATLANTIC SALMON CONSERVATION

## Conservation Stocking Programme

The brookstock was established in 1996. A significant numbers of eggs were needed but there were not enough wild fish available to use as broodstock.

### CARRON CATCH STATS SALMON/GRILSE

■ SALMON/GRILSE



River Carron Salmon Stocking 1995 to 2015:

Eyed ova	320,000
Un-fed fry	20,300
Fed fry	2,756,680
Parr	144,525
Smolts	104,689
<b>Total</b>	<b>3,346,194</b>



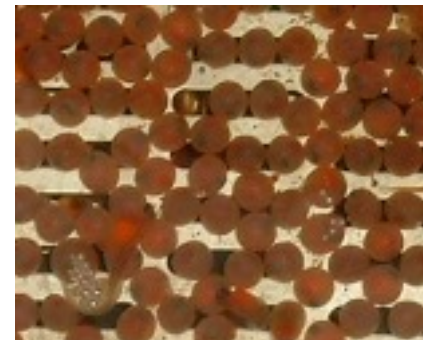
# WILD ATLANTIC SALMON CONSERVATION

## The Hatchery



The Carron Hatchery does not use electricity or pumped water and has a simple set up across three locations.

6 salmon hens stripped in November/December 2019 produced 38,671 stripped eggs with 38,410 eyed eggs at an overall survival rate of 99.3% to the eyed stage.





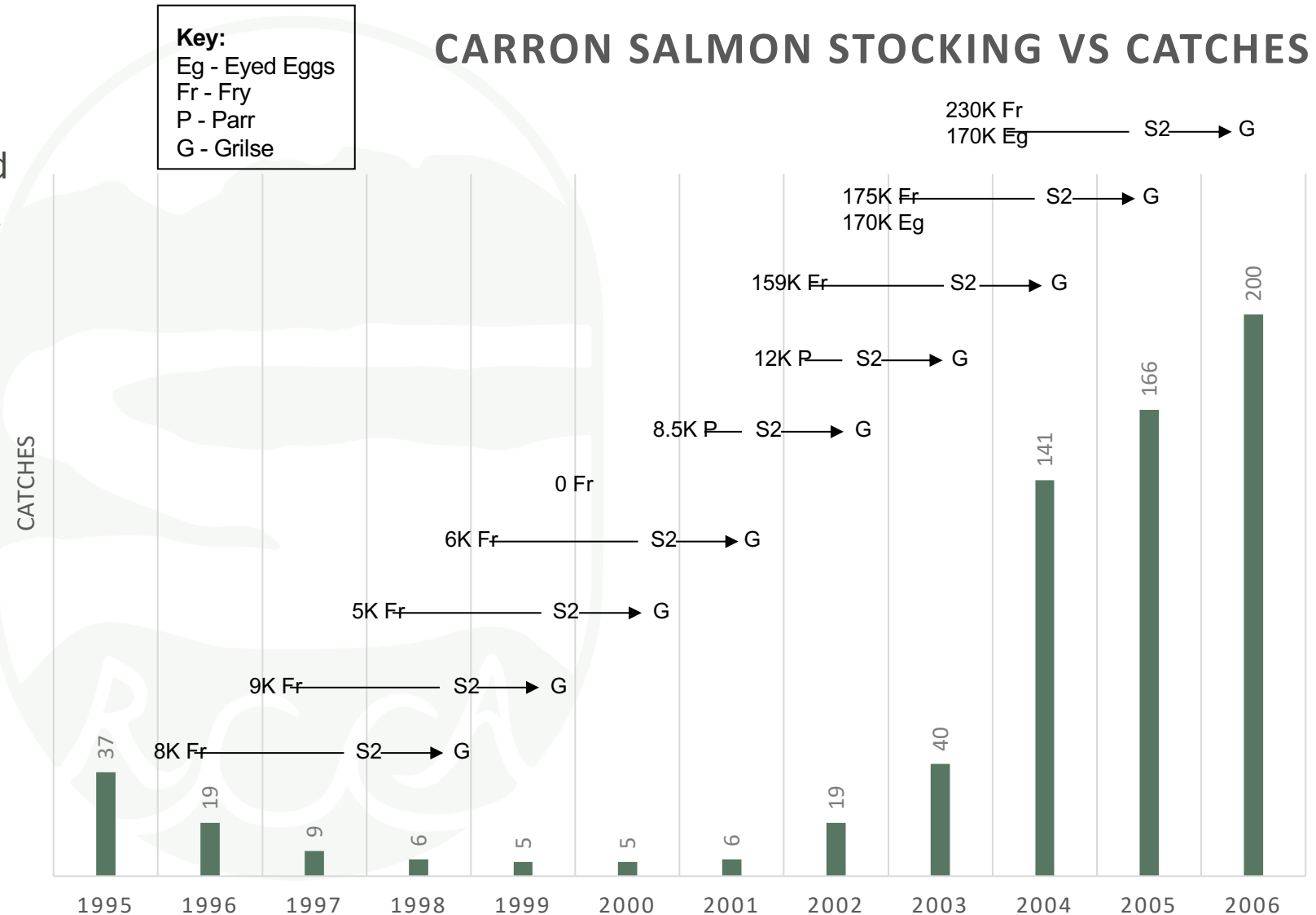
# WILD ATLANTIC SALMON CONSERVATION

## The River Recovery

The Riparian owners of the Carron have worked to improve the biodiversity glen. Around 370,000 trees have been planted on the Glencarron Estate alone.

In addition rigorous protocol and monitoring projects have been established to assess the contribution of stocked fish to the recovery of the Carron:

- Assessment of smolt output using a rotary screw trap
- Assessment of the incidence of multi-captures
- Extensive data collection
- Tagging Programme
- DNA Analysis





# WILD ATLANTIC SALMON CONSERVATION

## The Tagging Project

105,000 autumn salmon fry were tagged over 2006-2008 using coded wire tags (CWT) injected into their noses.

A total of 26,500 salmon smolts were similarly tagged in the following springs and all tagged fish were adipose fin-clipped.

Since 2008, a rotary screw trap has been positioned in the lower part of the river. The trap samples descending smolts and provides valuable information on:

- The overall smolt run
- The success of tagged salmon to the smolt stage
- The speed of descent of released smolts

### Screw Trap Results in 2010

5,144 un-clipped salmon smolts

822 clipped salmon smolts (from fish tagged in October 2008)

1,378 salmon smolts (released as S1 smolts)





# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project

Monitoring is key to the conservation of wild salmon and a database of information has been collected which could inform future conservation efforts.

Keen to exchange knowledge and carry out scientific research to analyse the success of the conservation programme a partnership was established with the Rivers and Lochs Institute at UHI over 20 years ago.

Scientific advances in DNA analysis created an opportunity to greatly enhance the understanding of the salmon population in the River Carron.

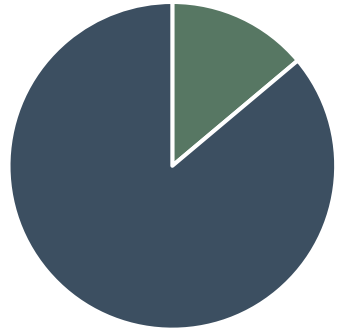
Over 6,000 samples of DNA have been collected to ascertain the success of stocked fish and their contribution to the revival of the River Carron.

833 samples have been analysed and revealed that stocking can not only contribute significantly to the fishery but can be done in a way that is sympathetic to the natural ecosystem while avoiding risks to the health and genetic integrity of the rivers' wild salmon population.

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### DNA SAMPLES COLLECTED

■ Analysed ■ Not Analysed





# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: The Broodstock

The eggs produced in the winter of 2014 and subsequently providing the fry for stocking in 2015, came from three distinct broodstocks. Fin clips were taken from each parent for identification by DNA analysis:

**Wild broodstock:** Hens and cocks caught on rod-and-line towards the end of the angling season. The eggs from each hen were fertilised using milt from a single cock.

**Attadale broodstock:** Captive broodstock produced by retaining some wild Carron eggs, incubating and hatching the eggs and then rearing to maturity entirely in freshwater. Eggs from up to 7 hens were combined before being fertilised by milt from a single wild cock to avoid the risk of crossing siblings.

**Uist Broodstock:** As with the Attadale broodstock, this stock was produced from Carron wild eggs. In this case eggs from several pairs of MSW hens and MSW cocks were retained and transferred to North Uist by the Scottish Salmon Company. This stock was reared through to the S1 smolt stage in freshwater tanks then to maturity in sea water cages.





# WILD ATLANTIC SALMON CONSERVATION

The DNA Project: A Stocked Salmon





# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: The Numbers Game

Stocking is a numbers game, to get a significant return of adult fish to the river large numbers of young fish need to be stocked out. This is demonstrated by the number of adults returning to the river.



### Adult Returns in the Rod Catch per Broodstock

Increase juvenile numbers through stocking



Higher smolt output



More returning adults

Broodstock	Stocked Fry	Adult Returns in the Rod Catch
Wild	98,500	2,814
Attadale	55,250	3,683
Uist	94,000	2,765

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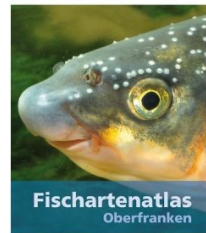
Institute for Biodiversity and Freshwater  
Conservation

# Conservation Genetics of the River Carron Atlantic Salmon Population



*Dr Bernd Hänfling*

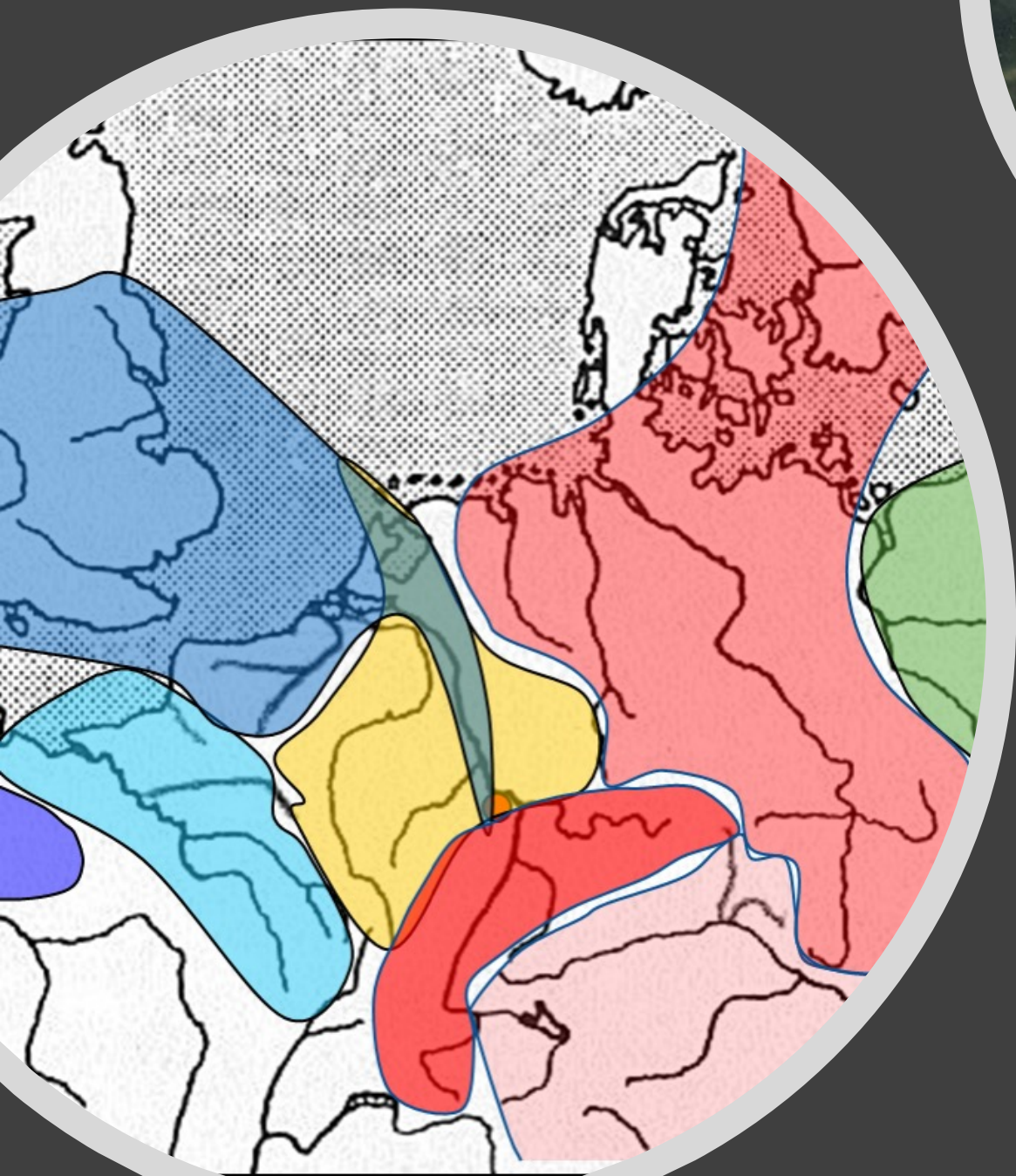




*Dr Bernd Hänfling*  
Background in fish and  
fisheries







*Dr Bernd Hänfling*

PhD project – genetic differentiation of fish populations across European catchments



25 years of research in molecular freshwater science





# Institute for Biodiversity and Freshwater Conservation

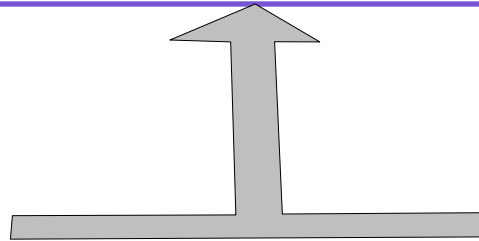
Molecular Ecology and Freshwater Genetics Group

Forestry and Wildlife Ecology Group



Rivers and Lochs Institute

Forestry and Conservation Group



← Landscape Ecology, Rewilding, Natural Capital →



# **A Pilot Genetic Evaluation of the River Carron Atlantic Salmon Supplementary Stocking Programme**

***Institute for Biodiversity and Freshwater Conservation, UHI Inverness***

*Project Lead:* Dr. Victoria Pritchard

*Project Support:* Matthew Curran, Silvia Ferreira Carvalho, Dr. Barbara Morrissey, Dasha Svobodova

*Project Development:* Prof. Eric Verspoor, Prof. Melanie Smith, RCCA



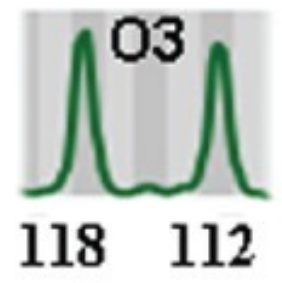
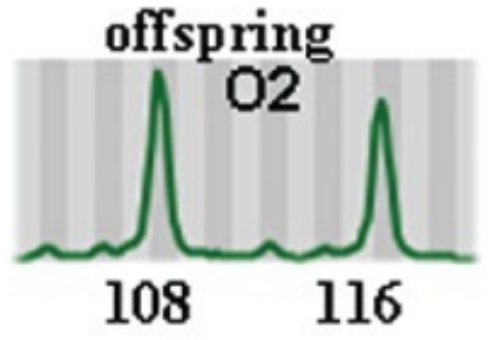
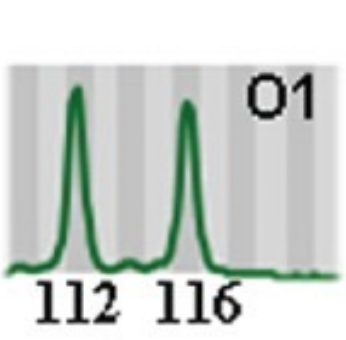
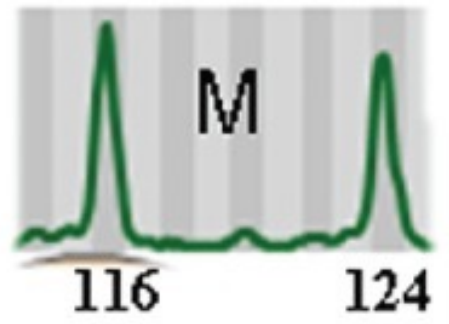
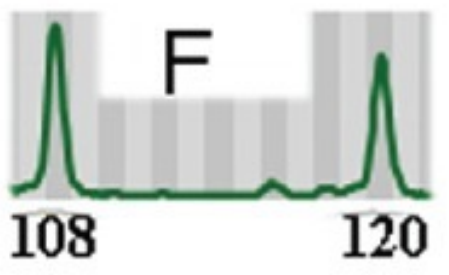
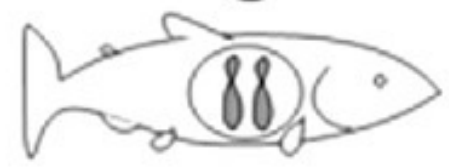
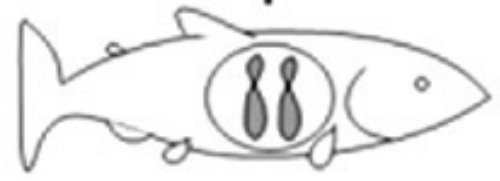
# What can genetic methods contribute to salmon conservation?

- Identify the origin of returning fish
- Quantify genetic diversity
- Assess the genomic contribution from non-native Aquaculture stock



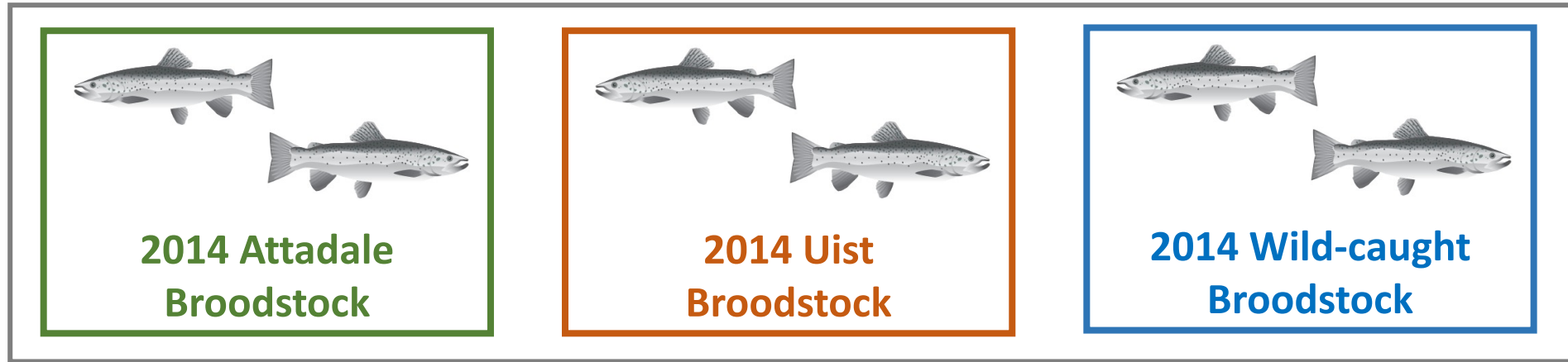


Potential parents

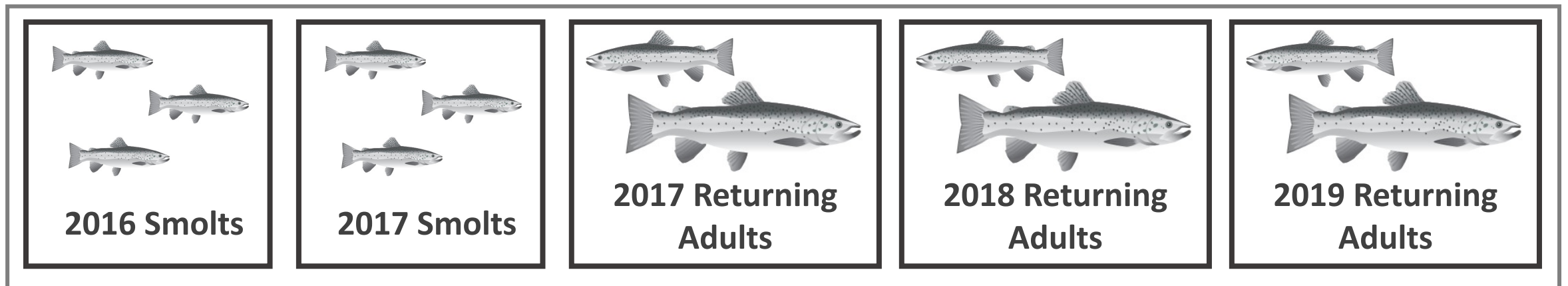


Q1: Do stocked juveniles survive and return to the Carron as adults?

# Answering Q1 for the 2014 broodstock spawnings



Genetic parentage reconstruction

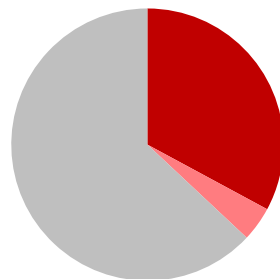




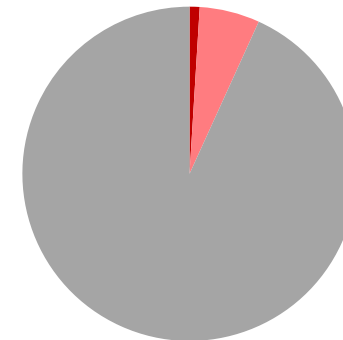
# Answer: Stocked fish DO return to the Carron as adults

## Fish Origin

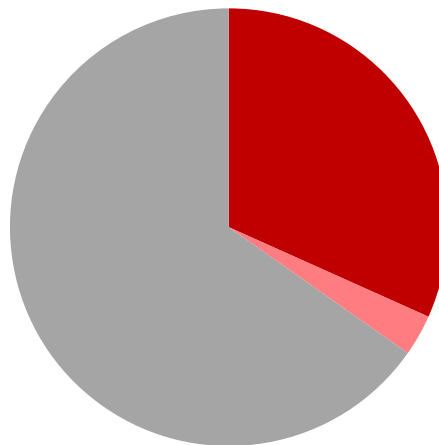
- 2014 broodstock cross
- Non-2014 broodstock cross with parent also in 2014 broodstock
- Wild spawning or other non-2014 broodstock cross



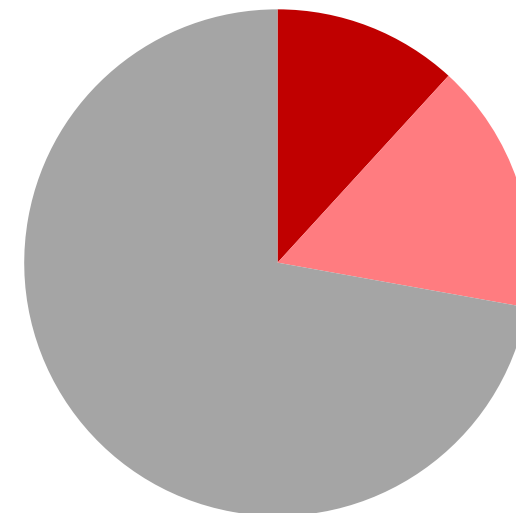
2016 & 2017 Smolts



2017 Returning Adults

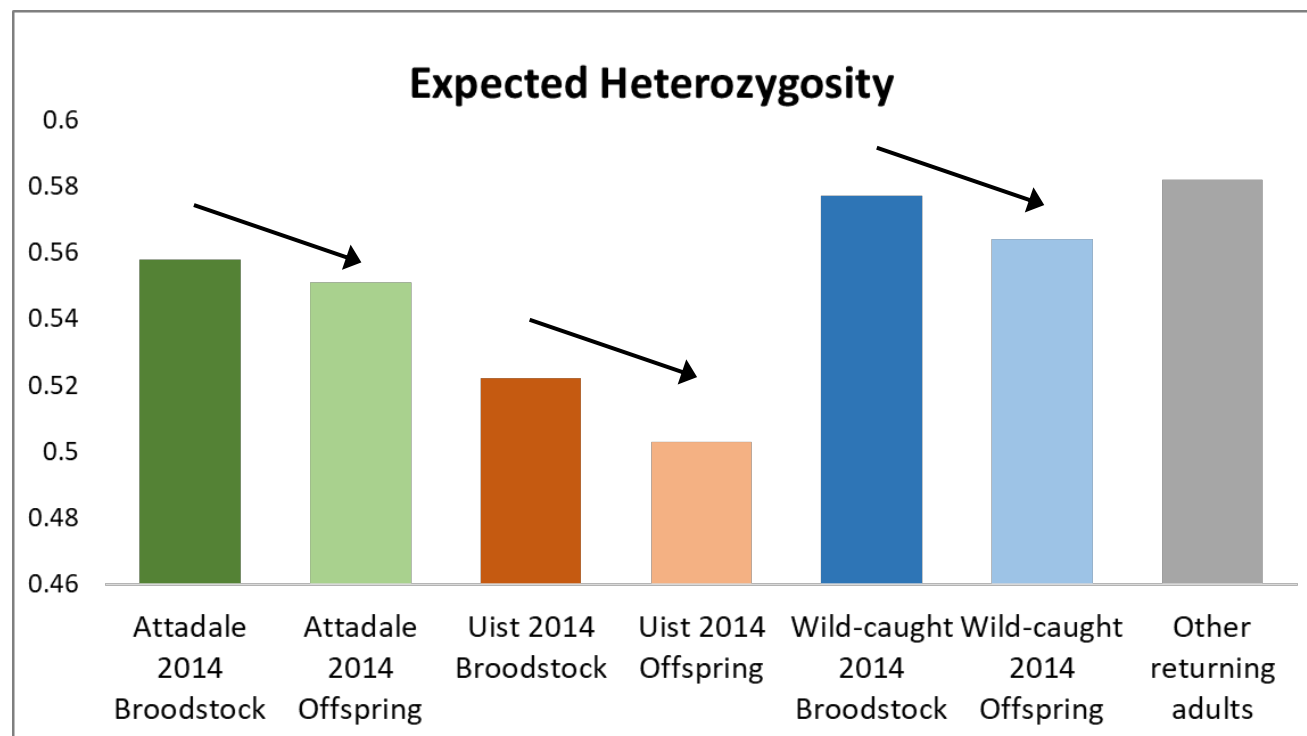


2018 Returning Adults



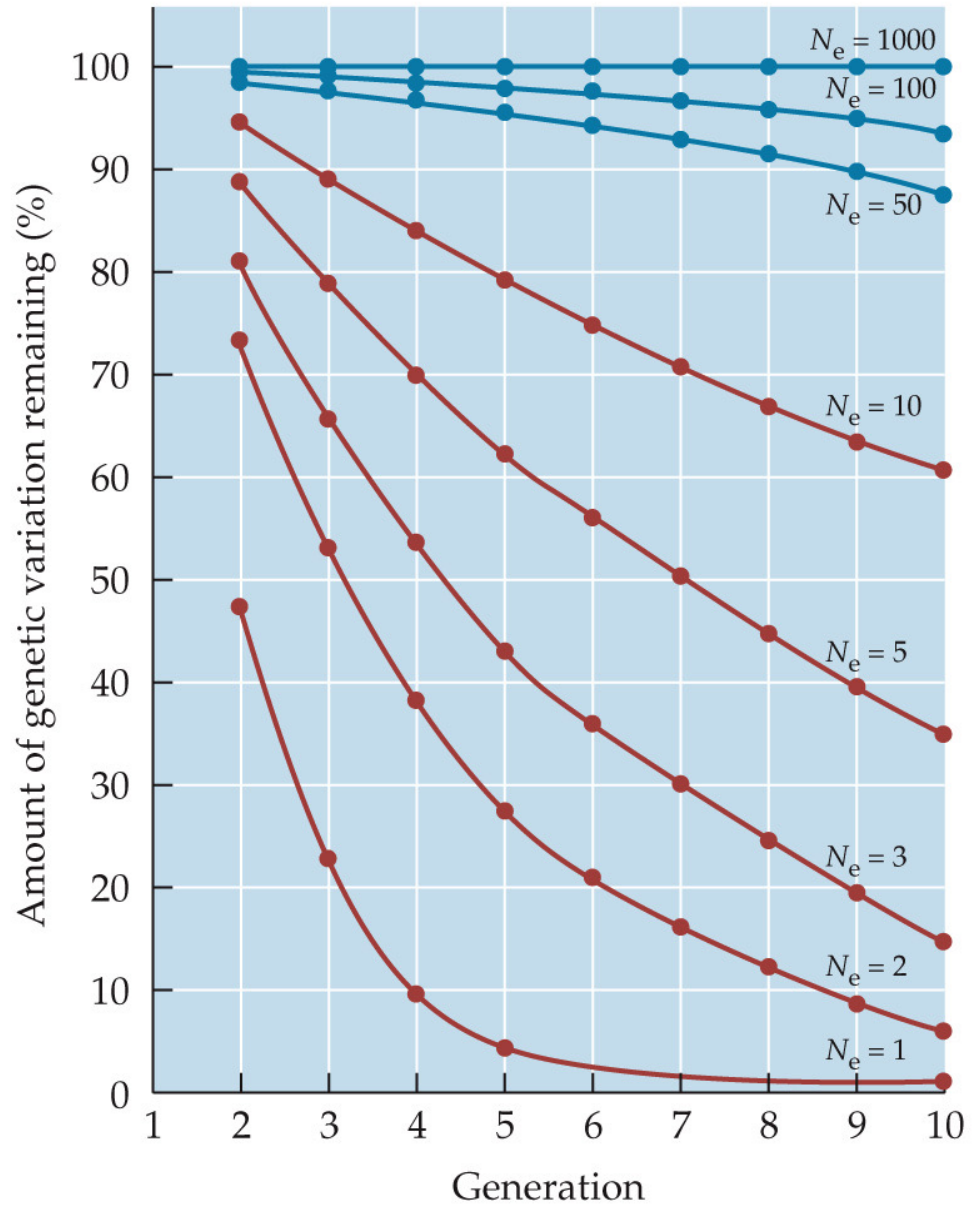
2019 Returning Adults

**Q2: Do known broodstock offspring and other returning adults differ in their genetic diversity?**



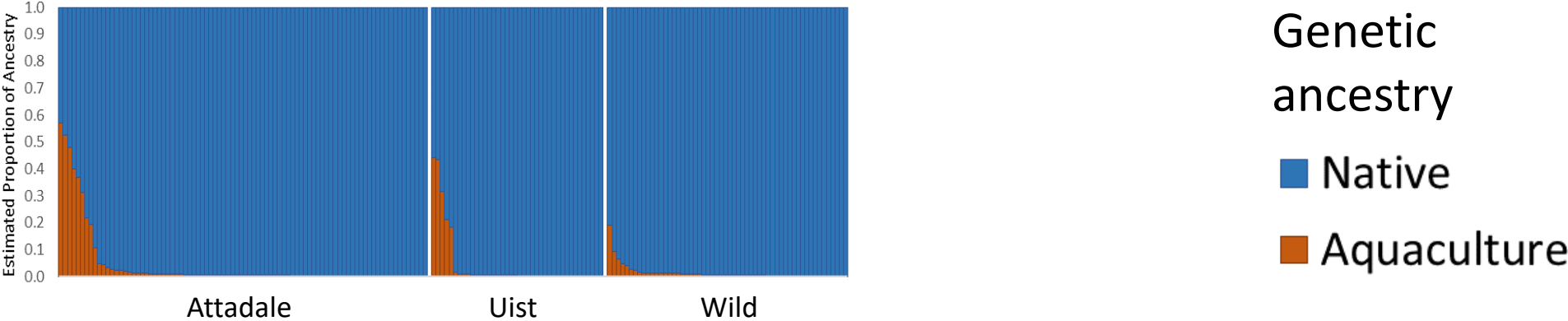


Small  
populations  
lose genetic  
variation  
over time

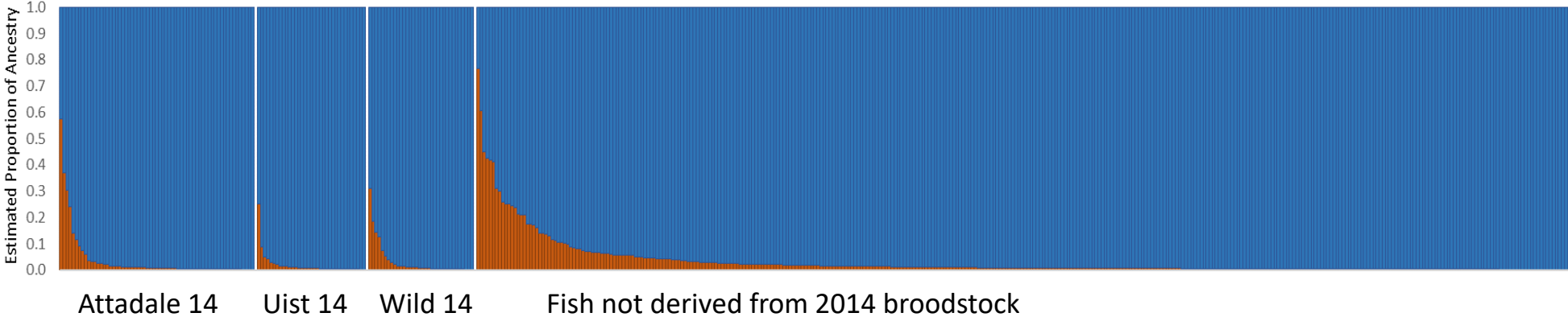


# Q3: Is there genetic material from escaped, Norwegian-ancestry aquaculture salmon in the Carron population?

2014 Broodstock



2017-19 returning adults

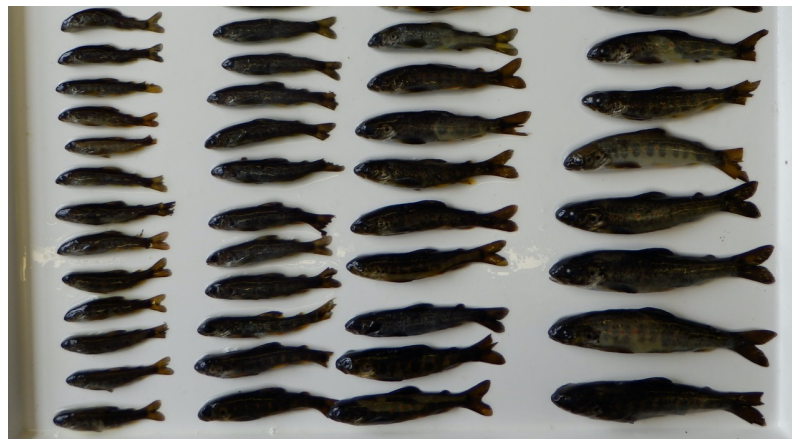




# Tissue samples collected across years as part of the Carron Atlantic salmon stocking programme

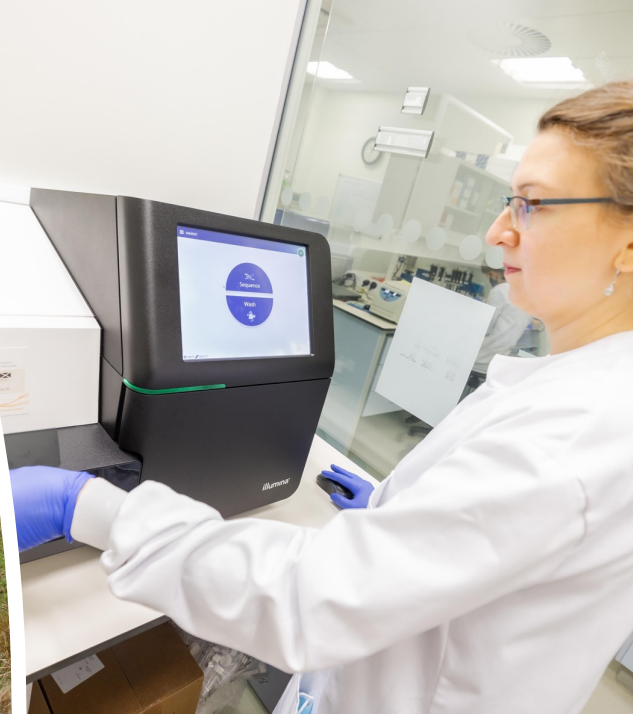


Broodstock parents	2011-2021
Returning adults	2013-2021
Electrofished juveniles	2012-2016
Out-migrating smolts	2013-2021





The Future...





# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: The Next Steps

The River has come back to life.

[www.carronconservation.scot](http://www.carronconservation.scot)

Through collaboration and open communication we can preserve wild Atlantic salmon for future generations.

UHI has ground breaking facilities within Scotland which allows for the fieldwork to be done where it is most relevant.

If we work together Scotland can lead the way in developing the science to help fight the decline of Atlantic salmon.



# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: The Stocking Locations

Table 1: Salmon Batches stocked out in 2015

Broodstock	Batch Number	Hens	Size Range (gms)	Fry Number	Stocking Location
Wild	1	13G	2.3 - 3.17	28,000	Kelso Beat
Wild	2	6S	2.7 - 2.9	22,000	Kelso Beat
Wild	3	15G	1.7 - 3.0	33,500	Glencarron Beat
Wild	4	1S	2.12	6,000	River Taodail
Wild	5 & 6	3G & 1S	4.1	9,000	Fionn Abhainn
Attadale	7	36	2.25 - 3.5	31,600	Arineckaig Beat
Attadale	8	10	4.8	5,100	Loch Sgamhain
Attadale	9	8	2.6 - 3.5	18,550	Attadale Beat
Uist		34	1.75 - 2.6	94,000	Arineckaig Beat Kelso Beat



# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: Stocking Locations

Table 2: Adult Returns in the Rod Catch per Batch

Batch Number	Adults in Rod Catch	Stocked Beat	Stocked Fry	Stocked Fry per Adult Return in Rod
1	14	Kelso	28,000	2,000
2	11	Kelso	22,000	2,000
3	4	Glencarron	33,500	8,375
4	1	River Taodail	6,000	6,000
5 & 6	5	Fionn Abhainn	9,000	1,800
7	10	Arineckaig	31,600	3,160
8	0	Loch Sgamhain	5,100	-
9	5	Attadale	18,550	3,710
Uist	34	Arineckaig & Kelso	94,000	2,765

# WILD ATLANTIC SALMON CONSERVATION

## The DNA Project: The Stocking Locations

Table 4: Stocked Hens Retained as Brookstock

Broodstock	Clip Number	Hen Weight	Stripped Eggs	Eyed Eggs	Percentage Eyed
Uist	ICO 066	8 lbs	4,383	4,350	99.2%
Uist	ICO 078	9 lbs	7,394	7,360	99.5%
Uist	ICO 085	10 lbs	6,100	6,000	98.4%
Attadale	ICO 062	22 lbs	11,450	11,400	99.6%
Attadale	ICO 067	10 lbs	5,816	5,800	99.7%
Wild	ICO 051	6 lbs	3,528	3,500	99.2%