

Invergarry power station

Smolt Passage Survival Trials

Dr Stuart Clough, Chief Client Officer, APEM Group
Andy Jacobs, Hydro Operations Environment Manager, SSE Renewables

apemltd.com



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Acknowledgements

Authors

- Stuart Clough & Matthew Heeps
APEM Group
- Andy Jacobs & Ross Glover
SSE

Project team *

- SSE – Dr Alastair Stephen, Alasdair Couttie
- REDS – Commercial Dive Team
- NESS DSFB – Chris Conroy, Chris Daphne & John McColl
- SEPA – Richard Fyfe
- Durham University – Dr Jeroen Tummers, Dr Martyn Lucas
- APEM Group – Paul Gratton

** Position and/or company details correct as at time of project*



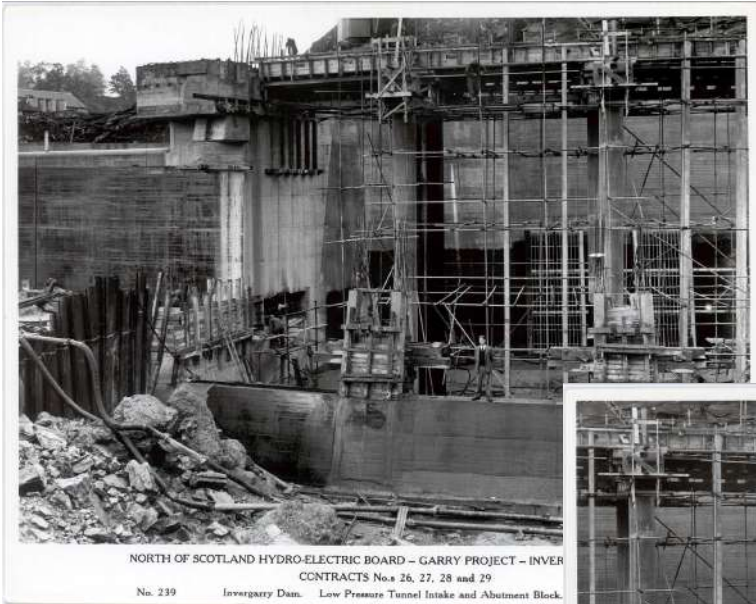
The Ness Catchment

High importance for Salmon and for renewable energy



Long term Hydro Schemes

- Hydro-electric schemes have been in place across the Ness catchment for many years, including Invergarry PowerStation.

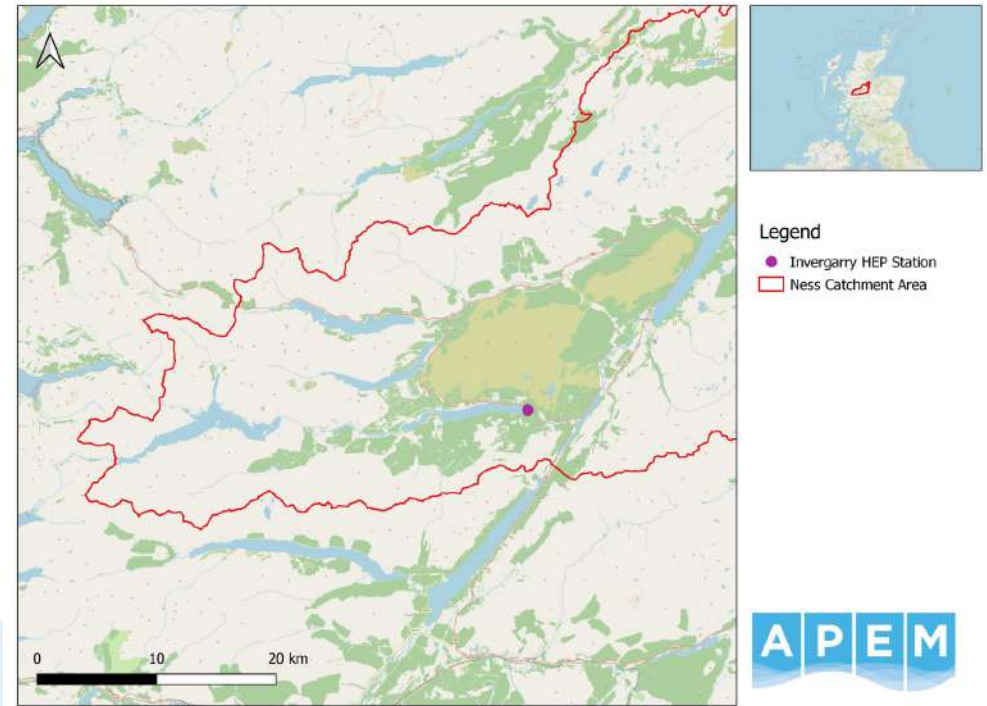


Photos of construction of Invergarry HEP station in 1955



River Garry Salmon Habitat

- The habitat upstream of Loch Garry offers a lot of potential for salmon production, and SSE work closely with the Ness DSFB as part of the Upper Garry Restoration Project.



Invergarry HEP station within the Ness catchment

Background

- Salmon numbers in the Upper River Garry have been in decline over the past 50 years
 - 1956-1969 between 300-900 returning adult salmon
 - 1970-1982 between 150-500 returning adult salmon
 - 1982-2000 between 100-300 returning adult salmon
 - 2000- 2023 between 25-150 returning adult salmon
- Historical mitigation has not been successful (Stocking, easing fish passage)
 - Invergarry hatchery used to stock the Ness catchment up until the late 90's
 - Fish hecks and barriers removed further upstream to open up more suitable spawning habitat
- Dr. Alastair Stephen came up with a novel idea to develop a project which would benefit both the Salmon and Hydro operations
 - Required a pragmatic approach to resolving hydro and fishery related challenges in order to provide suitable mitigation
- Operationally, the management and maintenance of screens was challenging, with resource, health and safety concerns and high costs of replacement of screens approaching life end

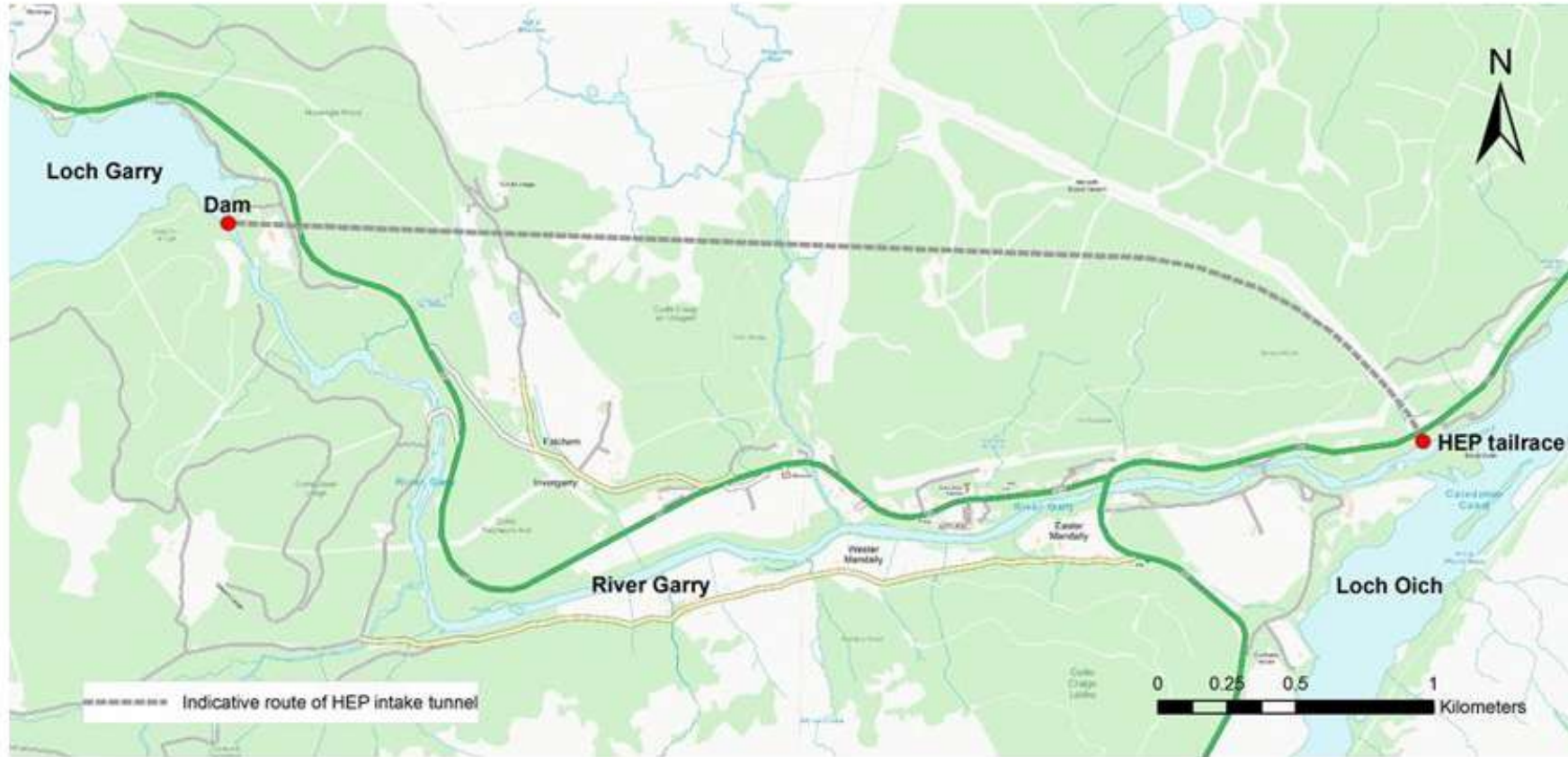


Background

- In 2012 the Rivers and Lochs Institute (RLI) were commissioned by the Ness District Salmon Fishery Board (NDSFB) to complete a scoping report on the development of a Salmon stock restoration project, all funded by SSE
- The recommendations of the report included:
 - Implementation of targeted, designed and linked enhancement initiatives
 - Habitat improvements
 - Stock rehabilitation
 - Supportive breeding and supplementary stocking
- Stakeholders brought together to form partnership and collaborate on the project
 - Scottish & Southern Energy (SSE), Ness and Beaulay Fisheries Trust (NBFT), The Ness District Salmon Fishery Board (Ness DSFB), Marine Harvest (MOWI), Scottish Environment Protection Agency (SEPA) and UHI Inverness College Rivers and Lochs Institute (RLI)



Site layout



The location of the Invergarry HEP intake at Loch Garry dam and the tailrace at the downstream end of the River Garry.



Fish migration at Invergarry

- Upstream migration of adult salmon at Invergarry is catered for by a Borland lift, a separate downstream passage designed for smolts is not provided.



A salmon passing through the counting flume in a Borland fish lift



Challenging downstream passage

- Screens and competing HEP intake attraction flow make it difficult for smolts to locate the entrance to the fish lift.



Passage through turbines

- Because of the design, survival of smolts passing through the turbines could be expected to be relatively high.
- Legislation however requires the route to the turbines to be screened to prevent ingress of smolts.
- As such smolts became trapped in Loch Garry and as such were likely to be subject to predation and very high levels of mortality.
- Via consultation - scheme operators (SSE), regulators and fisheries interests all agreed that allowing the smolts to pass through the turbines *might* provide a better survival rate than the current scenario with the screens in place.
- However, before this could be considered survival rates of smolts passing through the turbines would need to be understood.





Smolt Survival Assessment

APEM Study



The Brief

- APEM were contracted to work with SSE, local fisheries interests and regulators to design and implement a study that would allow the likely survival for smolts passing through the turbine to be estimated.
- This is a big site with very high discharge, and as such it was not the easiest place to conduct a fish survival study.



Invergarry tailrace with turbines switched off

The smolt trials..... and tribulations!

- APEM designed a study which involved very large strong nets attached to heavy metal frames to funnel smolts passing through the turbines into a live car arrangement.
- Fabrication of the frames was completed by SSE and installation required cranes and a team of divers.
- A continuous flow through system was designed to keep the smolts in good health until they were required.



Video



The smolt trials.....and tribulations!

- Due to the presence of the screens, hatchery reared salmon had to be introduced upstream of the turbines, and as such the whole procedure needed to be covered by a home office licence. (ASPA)
- APEM selected home office (ASPA) licenced researchers from to collaborate on the project.
- A continuous flow through system was designed to keep the smolts in good health until they were required
- A mark recapture experiment was undertaken with fish introduced upstream of the turbines and recaptured below.



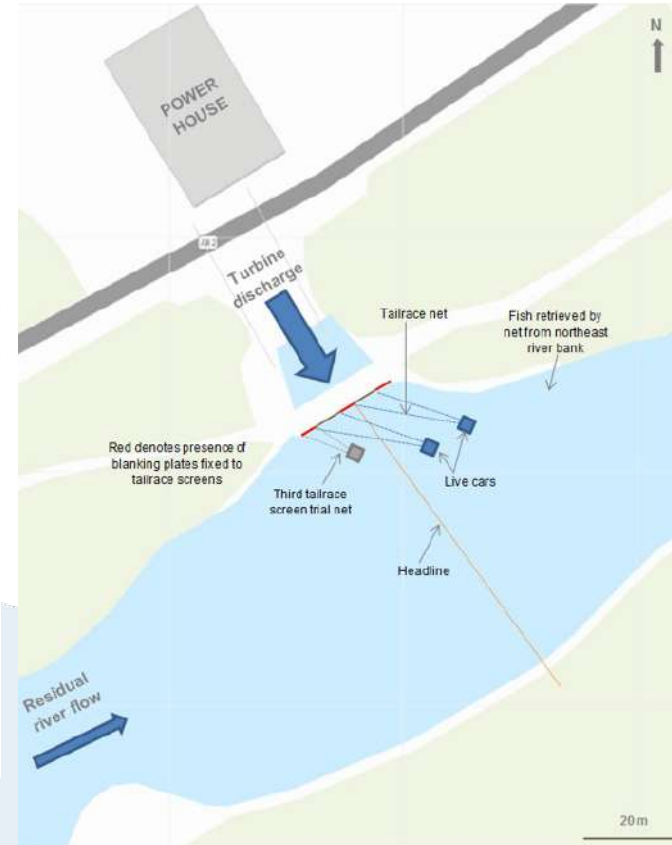
Smolt tagged with green elastomer, under UV light

APEM study design – Release and Recapture

The fish introduction pipe at the intake, extending down to the submerged intake opening.



Schematic of the tailrace netting arrangement



Safely recovering smolts from the tailrace live car arrangement



The Challenges

- The nets and frames were designed to provide the necessary filtration area, and to have the strength to withstand the pressure.
- During the initial trial the frames started to buckle and upon removal there was evidence of the nets starting to come away from the headline.
- Frames were strengthened and new even stronger nets were made.



That is a lot of flow!

Turbines off



Turbines on



The Challenges

A beautiful part of the world to work in...



...but beware the wee beasties!

Results

- An overall survival rate of 84% was established for 'treatment' fish passing through the turbine, after correcting for control mortality and the fate of uncaptured fish;
- Scale loss was observed in both the treatment and control groups, with a mean loss of 6.9% attributable solely to passage through the turbine.
- Passage of smolts through the tailrace screens caused a higher rate of scale loss and mortality than that attributed to passage through the turbine itself.

84%

survival rate

It was concluded that removing the intake smolt screens would likely result in increased smolt survival compared to the current scenario.

Smolt Behaviour Assessment

- Once the survival rate of smolts through the turbines had been ascertained, an additional concern was raised relating to other potential routes of downstream passage once the screens are removed.
- It was considered possible that instead of following the main attraction flow into the intake tunnel that smolts might instead be drawn towards the compensation flow which passes via a much smaller, but much less fish friendly turbine design.
- Further studies were designed to assess the movement and behaviour of smolts as they entered the intake bay of Invergarry HEP station, following removal of the smolt screens.
- Information was needed on how the smolts would behave in front of the turbine tunnel entrance, and whether it was likely that they would be attracted towards the comp set.
- The intake bay was also a very difficult place to conduct a fish behaviour study.



APEM study design – Video monitoring

- APEM designed a state-of-the-art study using strategically-positioned ARIS cameras to monitor the behaviour of wild smolts at full depth range of the loch in the vicinity of the turbine intake tunnel and comp set.



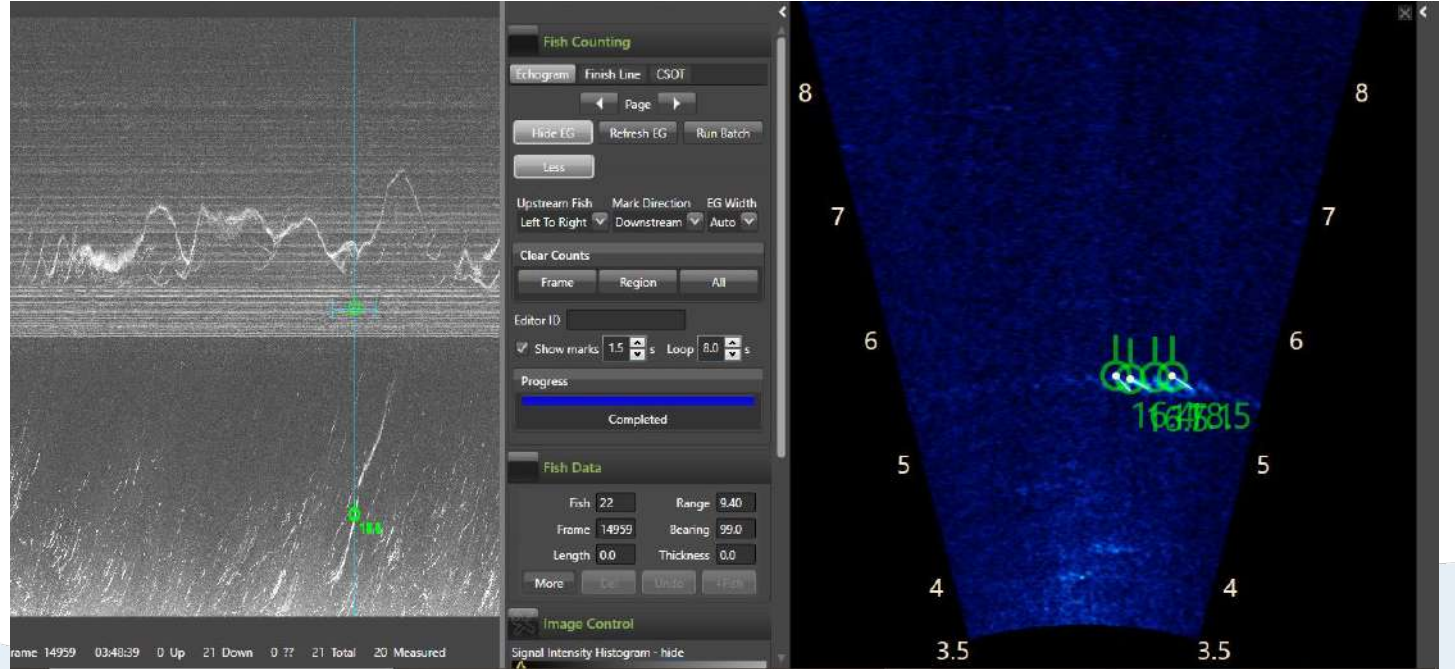
Diver installing study equipment



ARIS camera mount set up

ARIS footage Analysis & Results

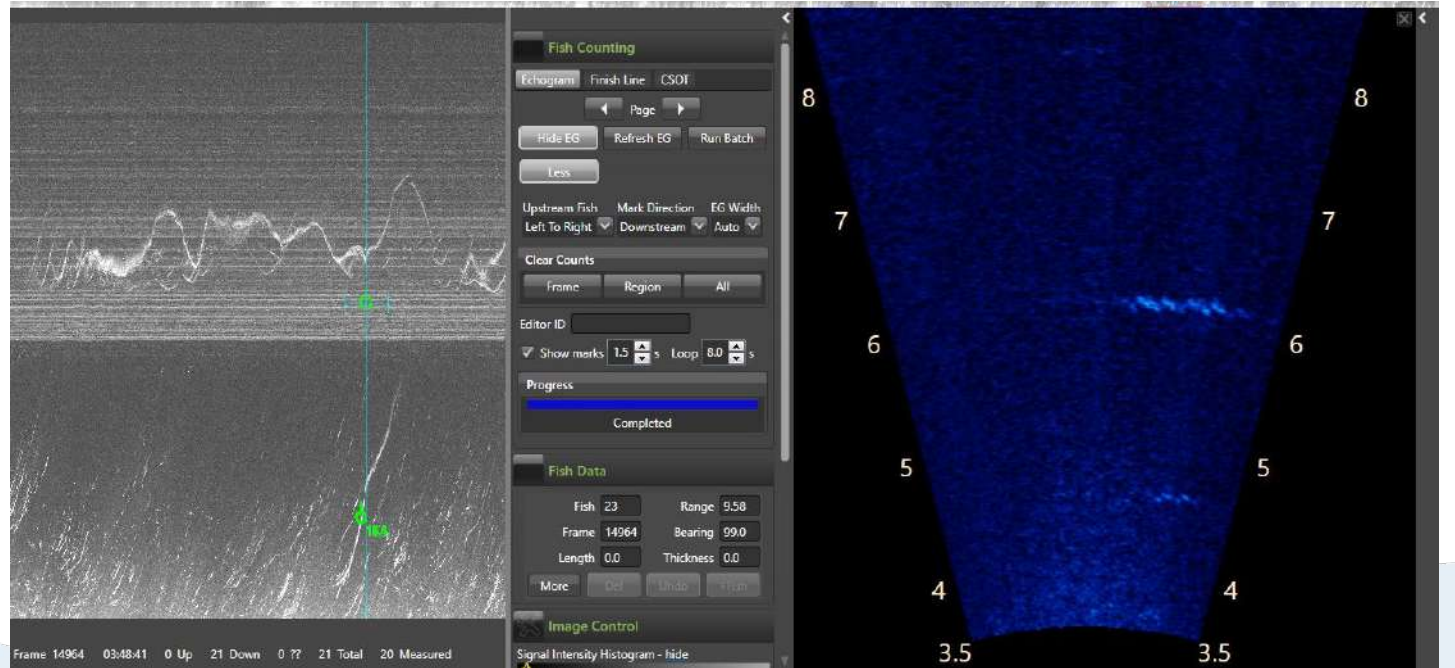
- Footage was processed using the ArisFish software to first identify individual/ groups of smolts from echogram outputs.



Echogram output (left), raw footage review of target fish (right)

ARIS footage Analysis & Results

- Then the clearest images of target fish were isolated to accurately measure size, direction of movement and behaviour.
- This study concluded that there was no/ very little attraction to the comp set, and that most fish would pass downstream via the main turbines.



Ecogram output (left), raw footage review of target fish (right)

The final outcome – a win win win

- Consensus was reached that removing the smolt screens permanently and allowing the smolts to pass via the turbines would be a better outcome for the River Garry salmon population.
- This project was a **win-win-win** - It was a win for **salmon**, a win for **renewable energy production** at the Invergarry site, and a win for **collaboration**, with operator, regulator, local fisheries interests and expert consultants all coming together to find a mutually acceptable solution to a difficult fish migration challenge.



Thank you



+44 (0)161 442 8938
enquiries@apemltd.co.uk
apemltd.com



Questions?

<https://www.sserenewables.com/>