Fish surveys on the River Eden, Fife, in relation to the removal of Gateside Mill Weir

Introduction

Gateside Mill Weir, a redundant mill weir and associated sluice (Figure 1), was removed from the River Eden near the village of Gateside, Fife, in the summer of 2022. The weir presented an impassable barrier to the migration of salmon, sea trout and migratory fish, preventing their accessing valuable spawning and rearing habitat further upstream. This weir removal was funded by the Scottish Government's Water Environment Fund (WEF), and was commissioned directly by the Scottish Environment Protection Agency (SEPA).

Figure 1: Gateside Mill Weir prior to removal

Method

To determine the success or otherwise of the weir removal, electrofishing surveys were carried out prior to and after the weir was removed, in September 2021 and September 2023 respectively. The map below (Figure 2) shows the locations of these fish surveys along with the location of the weir itself. Surveys were carried out in three locations in each year, in habitat considered to be suitable for salmonids in particular. These sites were approximately 400m downstream of the weir (site SEPA_600513, Figure 2) to determine what fish species were present downstream of this structure,

and at distances of approximately 60m and 2km upstream of the weir (sites SEPA_600514 and SEPA_600515 respectively) to determine whether or not its removal had improved fish passage.

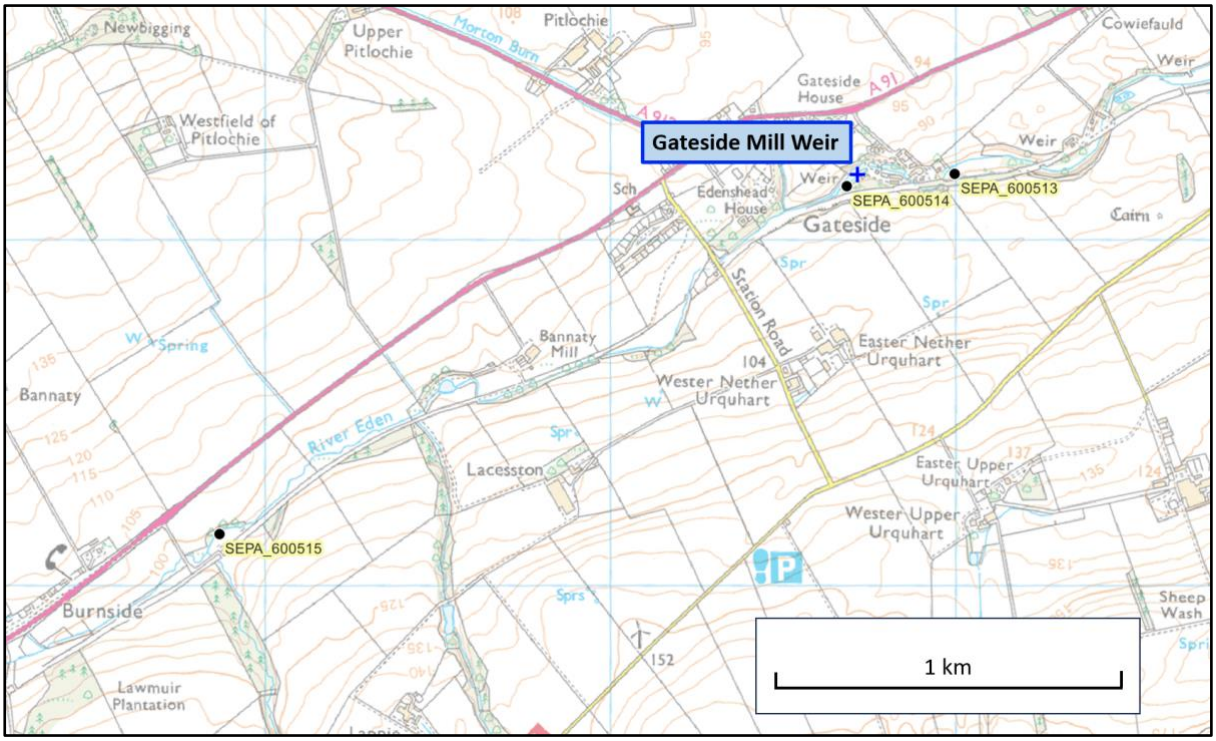

Figure 2: Map showing the location of the now-removed Gateside Mill Weir (blue cross) and the locations of electrofishing surveys (black circles) carried out by SEPA in 2021 (pre-removal) and 2023 (post-removal). Survey site location codes are also shown.

All surveys were carried out by experienced SEPA fish ecologists using standard electrofishing protocols used throughout Scotland[1]. Single-run, quantitative surveys were employed in every case. The backpack electrofishing equipment used (E-Fish 500W backpack system) was set to provide a smooth DC output to minimise any risk of injury to fish and no fish mortalities were recorded in any of the six surveys carried out during this work. All fish stunned were captured using hand nets and transferred to buckets of river water. Once each site had been surveyed, fish were then lightly anaesthetised to enable each fish to be speciated and measured. Details of fish caught, along with those of the habitat in the site, were recorded on standard survey forms for later analysis (see [1] below).

Because the area of river surveyed at each site and in each year varied, numbers of fish caught were converted to density estimates, i.e. numbers of fish per 100m^2 area. Separate density estimates were calculated for salmon fry[2] and parr[3], and trout fry[2] and parr[3], to provide a greater understanding of fish populations at each site. These species- and age-specific density estimates should be considered

[1] Scottish Fisheries Co-ordination Centre (2021) Team Leader Electrofishing Training Manual, 79p.
[2] Fry are the young-of-the-year fish i.e. those that hatched out in the preceding spring, less than one year old
[3] For the purposes of this report, parr includes any juvenile salmonids older than fry i.e. any fish of one year old or more.

as minimum densities of fish only, because single-run surveys rarely catch the overwhelming majority of fish in section of river or stream.

Results

As stated above, three sites were surveyed in each of September 2021 and September 2023, and the numbers of fish caught of each species (Atlantic salmon) and life stage (brown / sea trout) and lifestage (fry and parr) were used to estimate minimum density estimates of these fish. These density estimates are presented in Table 1 below and graphically in Figure 3 for salmon and Figure 4 for brown / sea trout.

			Minimum estimated density of fish present (n per 100m^2)			
Site Code	**Description**	**Date**	**Salmon fry**	**Salmon parr**	**Trout fry**	**Trout parr**
SEPA_600513	400m DS Gateside Mill Weir	10/09/2021	24	3	69	8
		12/09/2023	37	1	52	5
SEPA_600514	Immediately upstream Gateside Mill Weir	10/09/2021	0	0	37	4
		12/09/2023	29	0	53	1
SEPA_600515	2km upstream Gateside Mill Weir	10/09/2021	0	0	182	2
		12/09/2023	4	9	89	18

Table 1: Minimum estimated densities of salmon and brown / sea trout in the River Eden, Fife, 2021 and 2023

As can be seen in both Table 1 and Figure 4, brown / sea trout fry and parr were found at all sites in both years. In contrast, salmon were only found at the lowermost site (site SEPA_600513 downstream of the weir) in 2021, but were found at all three sites in 2023. Salmon fry were found immediately upstream of the weir in 2023 but no salmon parr were recorded there. However, salmon fry and parr were found at the uppermost site (approximately 2km upstream of the weir) in 2023, albeit that salmon fry were at the lowest density observed in any survey where salmon were found. A photograph of samples of the salmon and caught at this uppermost site in 2023 is presented below (Figures 5).

With the exception of one eel of 380mm length caught at the lowermost site in 2021, no other fish species were found during any of these surveys.

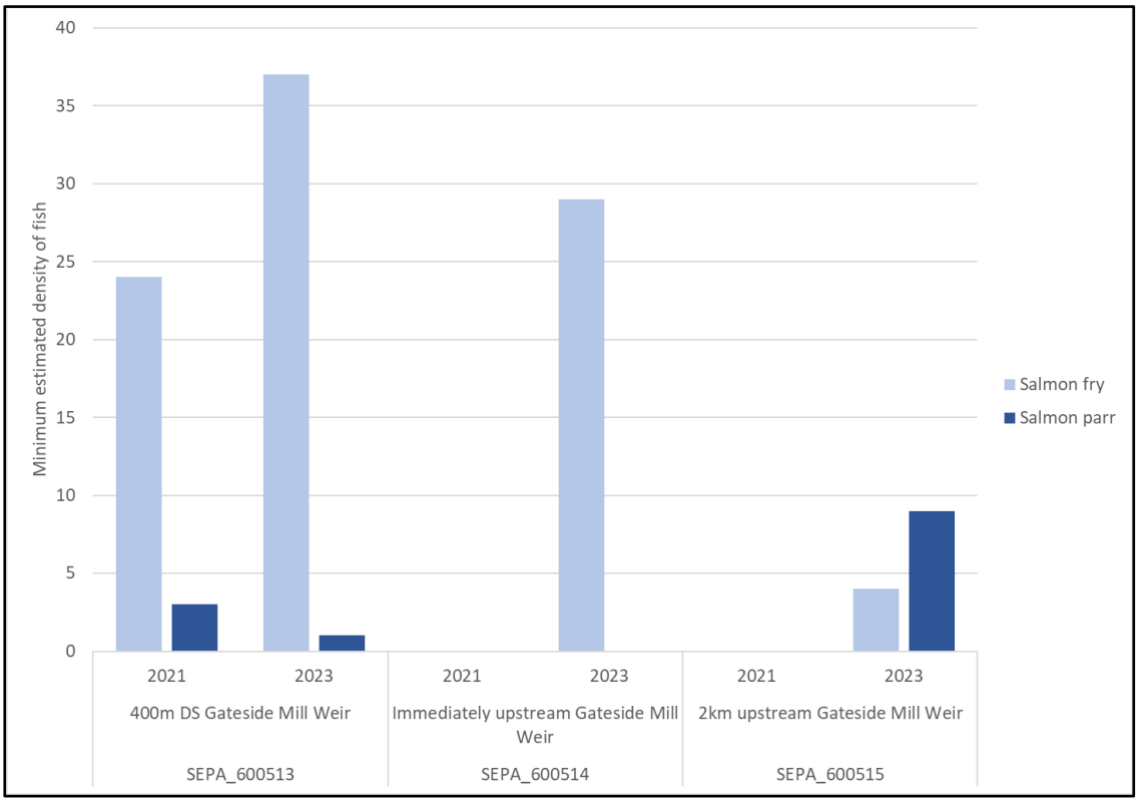

Figure 3: Minimum density estimates of salmon fry and parr in the River Eden, Fife, in 2021 and 2023. Estimates are show for each year, site and lifestage separately.

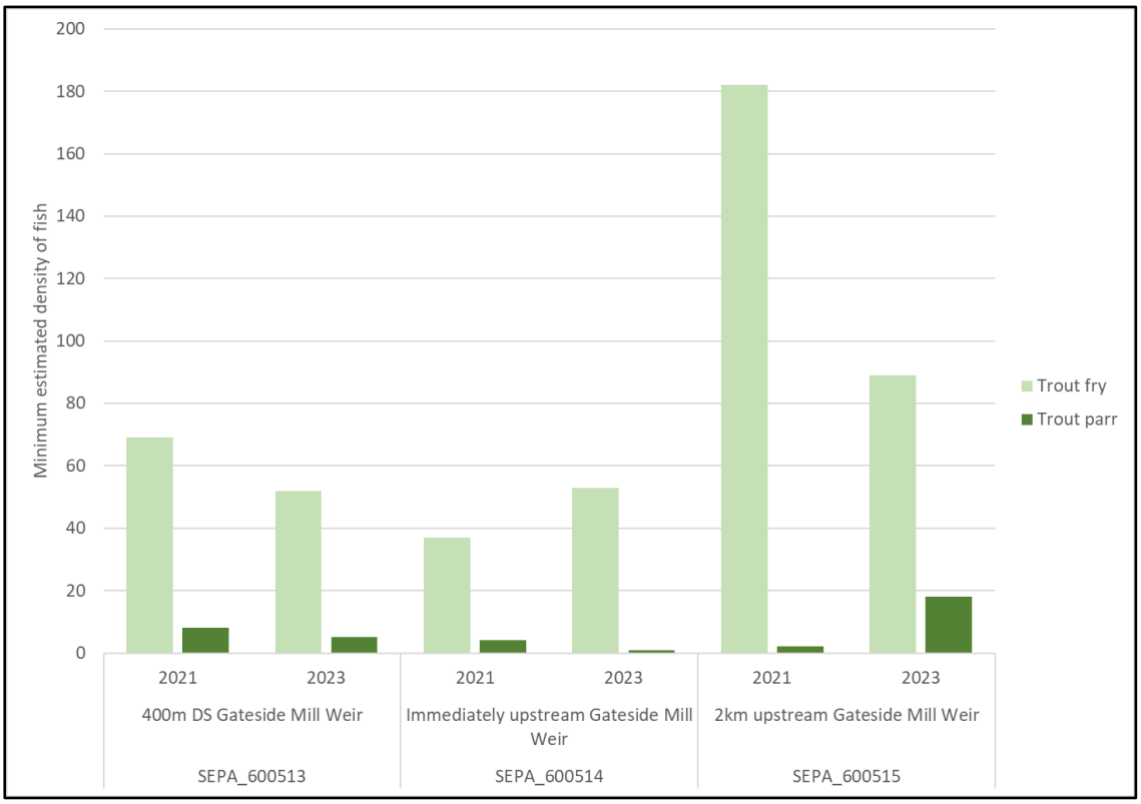

Figure 4: Minimum density estimates of brown / sea trout fry and parr in the River Eden, Fife, in 2021 and 2023. Estimates are show for each year, site and lifestage separately.

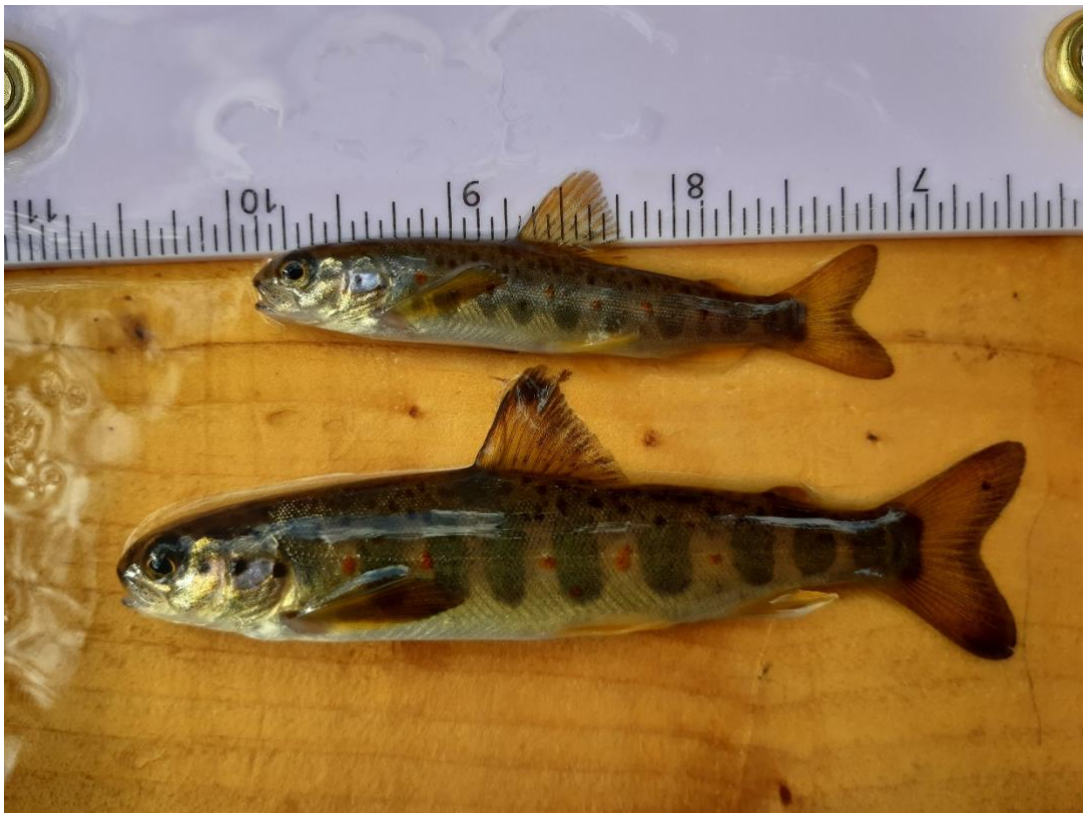

Figure 5: An Atlantic salmon fry (top) and parr (bottom) caught in the River Eden approximately 2km upstream of Gateside in September 2023. The scale is in inches.

Discussion

Six electrofishing surveys were successfully completed on the River Eden in the Gateside area, three each in 2021 and 2023. The key aim of these surveys was to determine whether or not the removal of Gateside Mill Weir (Figure 7) enabled migratory fish to utilise the upper reaches of the River Eden i.e. those reaches upstream of where the weir previously stood.

The surveys carried out in 2021 found that brown / sea trout were present in relatively good densities at all three sites prior to removal of the weir, so weir removal was not anticipated to increase the range of this species. Although brown trout fry densities were markedly lower at the uppermost site after weir removal than prior to removal (site SEPA_600515 in 2021 and 2023), Densities in 2021 remained very good and higher than any of those recorded during any other surveys carried out as part of this study. At the two lower sites, trout fry densities were similar in 2023 to those recorded in 2021. Trout parr densities in all surveys were markedly lower than fry densities – this is entirely normal and reflects the typically large mortality rate in all juvenile salmonids between the fry and parr lifestages, as density-dependent influences such as habitat availability take hold.

Whilst juvenile brown / sea trout were present in the 2021 surveys carried out upstream of Gateside Mill Weir prior to its removal, neither Atlantic salmon fry or parr were found. The lack of both year classes of salmon at both sites in 2021 is a clear indication that the weir was impassable to these species and, given the nature of the structure, most fish species in most years. Electrofishing surveys carried out as part of this investigation, however, found salmon fry at both upstream sites in 2023, albeit at relatively low levels at the uppermost site. This finding demonstrates that removal of Gateside Mill Weir has enabled salmon to migrate into the upper reaches of the Eden for the first time in many years, increasing their range and ultimately the numbers of salmon smolts and returning adults the river can produce.

Figure 7 : The River Eden, Gateside, where Gateside Mill Weir stood until it's removal in the summer of 2022.

Interestingly, salmon parr were also recorded at the uppermost site in 2023, some 2km upstream of where the weir was located. This could be due to the phased approach of weir removal at Gateside Mills whereby the landowner removed stop logs in the weir sluice in early 2021. This may have allowed some salmon to reach upstream of the weir and spawn in late 2021. The alternative is that complete removal of the weir in 2022 has enabled juvenile fish to disperse further upstream and occupy newly available habitat there.