5 Controlling River Bed Levels, Water Levels and Flows

5.3 Restoring and stabilising over-deepened river bed levels

RIVER OGWEN AND NANT FFRANCON

LOCATION - 5km south of Bethesda, Gwynedd SH 641615

DATE OF CONSTRUCTION - Autumn 1998

LENGTH – 900m

COST - £48 000 construction, £8 000 flood model, £5 000 design

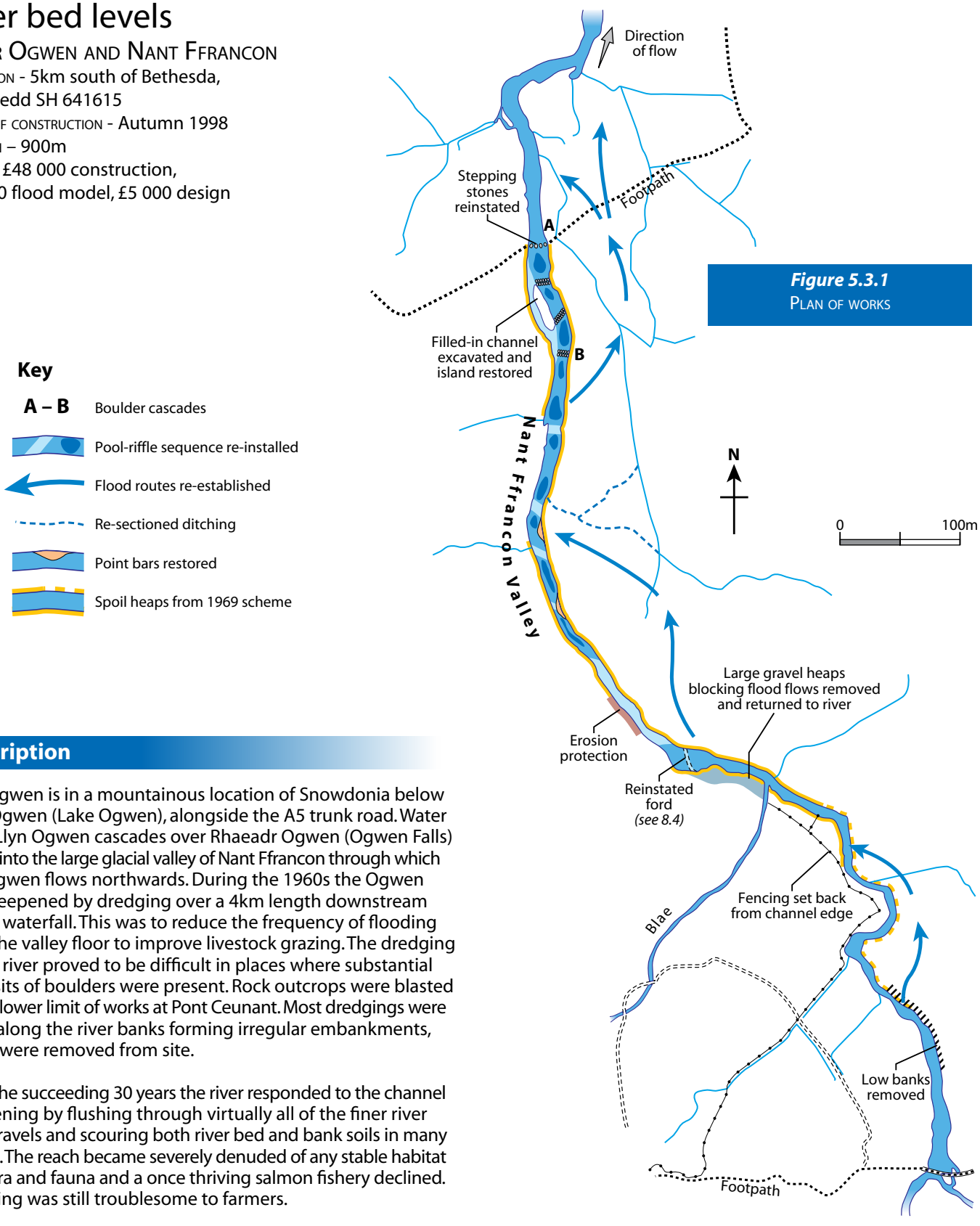

Figure 5.3.1
PLAN OF WORKS

Description

The Ogwen is in a mountainous location of Snowdonia below Llyn Ogwen (Lake Ogwen), alongside the A5 trunk road. Water from Llyn Ogwen cascades over Rhaeadr Ogwen (Ogwen Falls) down into the large glacial valley of Nant Ffrancon through which the Ogwen flows northwards. During the 1960s the Ogwen was deepened by dredging over a 4km length downstream of the waterfall. This was to reduce the frequency of flooding over the valley floor to improve livestock grazing. The dredging of the river proved to be difficult in places where substantial deposits of boulders were present. Rock outcrops were blasted at the lower limit of works at Pont Ceunant. Most dredgings were piled along the river banks forming irregular embankments, some were removed from site.

Over the succeeding 30 years the river responded to the channel deepening by flushing through virtually all of the finer river bed gravels and scouring both river bed and bank soils in many places. The reach became severely denuded of any stable habitat for flora and fauna and a once thriving salmon fishery declined. Flooding was still troublesome to farmers.

These techniques were developed to suit site specific criteria and may not apply to other locations

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Deep channel and dredgings on bank at Blaen-y-Nant confluence

Restored bed levels and bank profile

An appraisal of the problem concluded that far too much floodwater was being conveyed in the enlarged channel and that it would be necessary to restore pre-works river bed profiles to correct this imbalance. Re-routing of more frequent floods over the floodplain fields would result from this, helping to sustain other desirable habitats.

Detailed designs were prepared and implemented for the upper 1km of the river, close to Rhaeadr Ogwen, after detailed consultation with the National Trust (landowners) and farmers.

Design

Stage I works (Figure. 5.3.1)
The figure shows the extent of restoration works undertaken. Figure 5.3.2 shows the longitudinal profile of the reach and highlights the extent of river bed restoration needed. The long profile was the most important design reference.

The profile of the floodplain fields clearly indicated strong post-glacial influences on the natural landforms. Downstream of chainage 0m the fields lie horizontal and comprise an old lake bed (*Figure. 5.3.2*). The fields rise steeply upstream to chainage 400m (at gradients of circa 1 in 100) but flatten to 1 in 600 upstream of this. The river dredgings along the steeply graded reach were predominantly glacial boulders and old Ordnance Survey maps indicated that an island in the river was once sustained at the same location.

It was therefore evident that a post-glacial 'dump' of large boulders at the island site was the primary control over the river bed levels and gradients, and the restoration of this feature became fundamentally important.

A boulder cascade (**A** to **B**) was designed comprising four drops of around 0.4m over a reach of 100m, giving an average gradient of 1 in 100 to parallel the natural field gradients alongside.

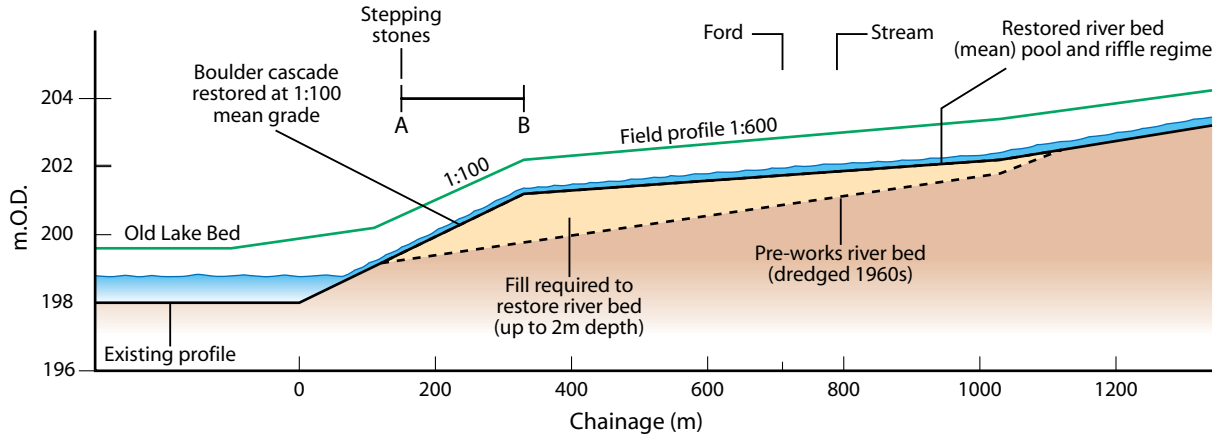

Figure 5.3.2
LONGITUDINAL PROFILE

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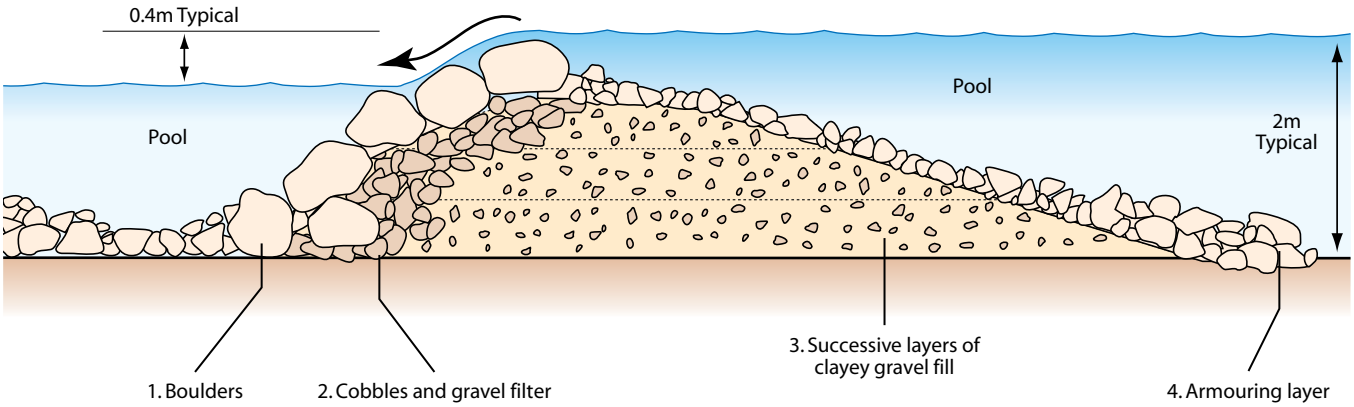
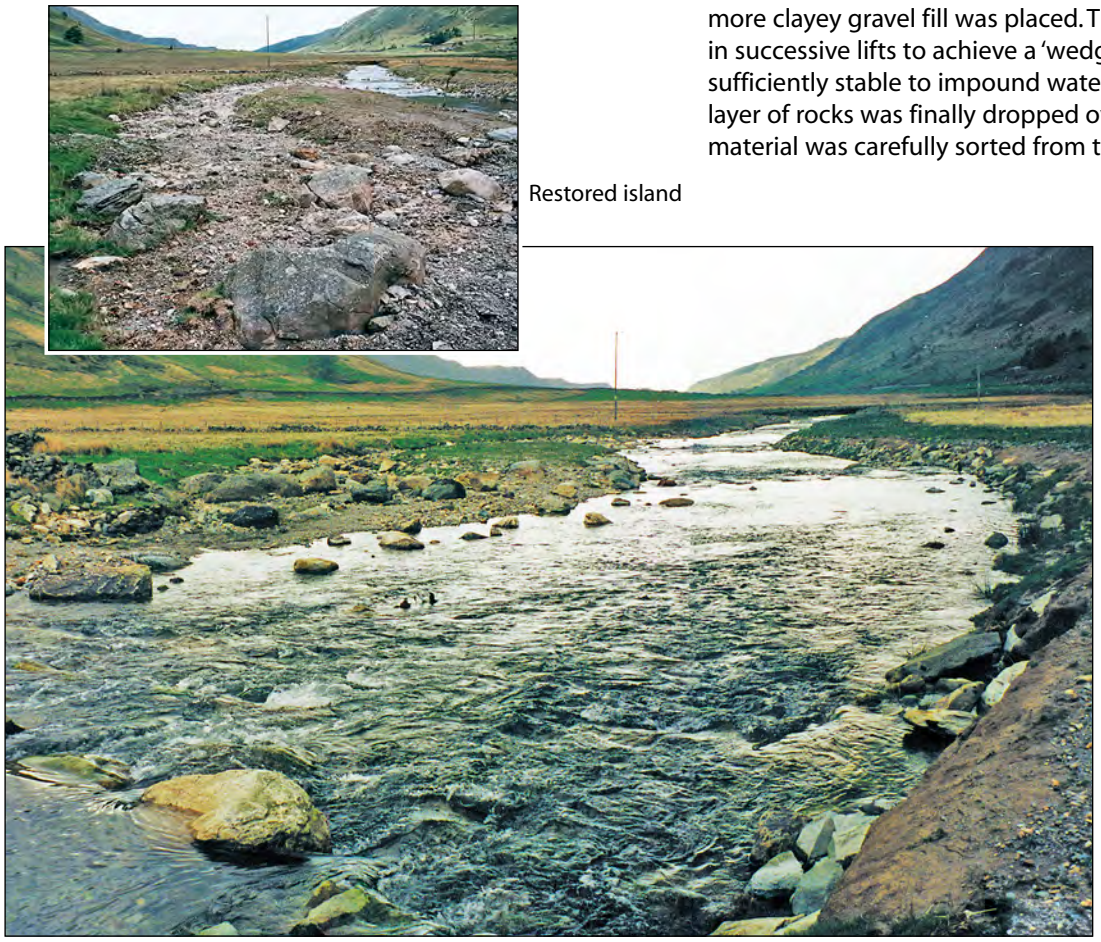
Figure 5.3.3
SECTION THROUGH A CASCADE



Old maps were studied to determine the planform, which included the secondary channel that formed the island. Trial digs were undertaken to determine the historic bed elevations and thus the crest level of the upper cascade. It was concluded that river flow around the island was probably a seasonal feature so the bed elevation here was kept marginally above restored river water levels consistent with site investigations.

The design for each of the four elements of the cascade is detailed in Figure 5.3.3. Boulders face-up more general fill in a structured way. Construction comprised a series of 'lifts' undertaken whilst the river was flowing over the works. Each lift comprises a line of selected boulders that are backed up by a layer of mixed cobbles and gravels that are sufficiently large not to eventually wash out through the interstices between boulders. Behind this 'filter' layer a further layer of more clayey gravel fill was placed. The structure was built up in successive lifts to achieve a 'wedge' shaped profile that is sufficiently stable to impound water upstream. An armouring layer of rocks was finally dropped over the general fill. All material was carefully sorted from the original dredgings.



Restored island

Restoration of boulder cascade, stepping stones and braided channel

These techniques were developed to suit site specific criteria and may not apply to other locations

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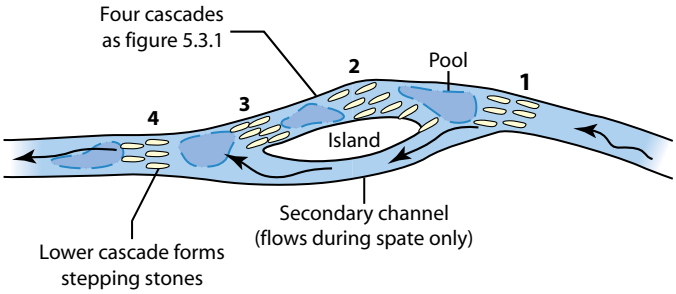
Lower 'stepping stone' cascade

Figure 5.3.4
PLAN OF CASCADES



The lower cascade was the smallest of the four so was readily adapted to restore a series of large stepping stones recorded on Ordnance Survey (OS) maps. The effect of restoring the cascade was to impound the upstream reach of river to a water depth of 2m. Ideally this upper reach would have been completely backfilled to the 1 in 600 gradient shown on Figure 5.3.2. but insufficient material was available for this because dredged gravels had been removed from site.

The practical alternative to full bed restoration was to concentrate the material available into a series of individual cascades along the upstream reach. These took a similar form to the main cascade but the downstream slopes were much flatter to simulate 'riffle' characteristics rather than true cascades. The upper of these 'riffles' at chainage 700m took the form of a long diagonal ford which restored a feature recorded on old OS maps – (*see Technique 8.4 for details of this ford*).

Flatter 'riffle' cascade with upstream pool

The remaining gravels and clayey gravel dredgings on site were all utilised to enhance the riffle/pool sequence that was created in the upper reach. Some runs of gravel bed were introduced near to the ford and shoals were built on the inside of bends.

A major erosion site downstream of the ford was reinstated using the willow mattress technique featured in this manual in *Technique 4.2*. The willow used was a species found locally (grey willow type) which sprouted well initially but has subsequently been grazed by livestock, although it has held firm.

The re-routing of floods overland was investigated by a combination of hydraulic modelling and close scrutiny of precise ground topography. It was found that by removing 'embankments' of dredgings at key locations floods would follow patterns that left open routes for retreat of livestock to 'high' ground, and that traditional lambing fields were the least prone to floodings. This was a critical element of discussion with farmers.

Subsequent performance 1998 – 2001

The works have transformed the visual appearance of the river from a deeply incised, canalised waterway to a shallower, wider regime that displays many more dynamic features as water tumbles over and between boulders into long pools and runs. Severe flooding during the succeeding two winters has not caused any significant structural damage to the restoration works and flood patterns overland are as predicted.

Improvements in the biodiversity of the reach and in the salmon fishery are being monitored by the Environment Agency. Early indications of the monitoring are all positive, but of particular note is the extent to which migratory fish are utilising the river rather than simply passing through to reach the limited spawning gravels that had survived the dredging works close to Rheaedr Ogwen.

Work is now in hand to progress further stages of works building upon the confidence gained from the success of stage I. This success was particularly useful in gaining financial support for the much wider 'Wetlands for Wales' project that has since been launched.

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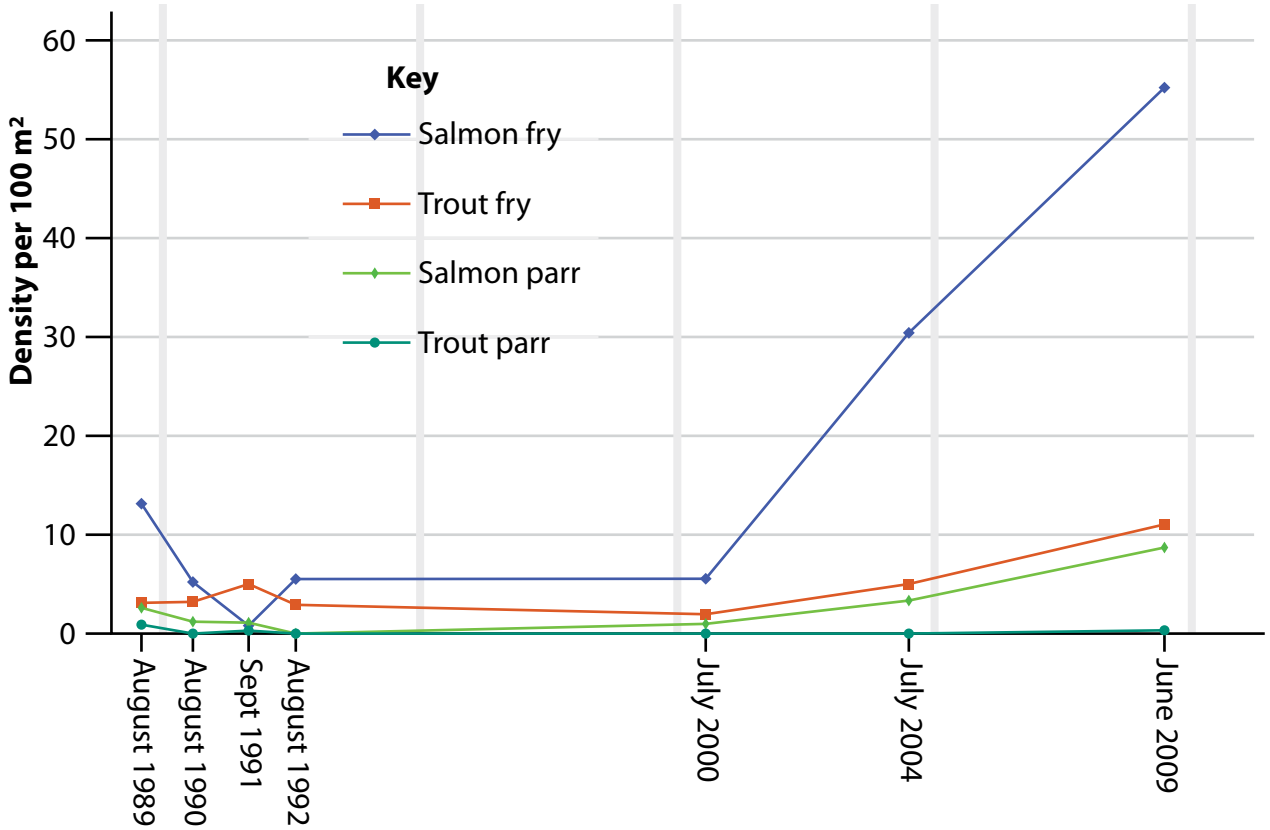
5.3 River Ogwen 2013 Update

River Ogwen	High energy, gravel
WFD Mitigation measure	**Click Here** to view details
Waterbody ID	GB110065054160
Designation	None
Project specific monitoring	Fish

No negative consequences of raising the bed level have been observed, however there were some stability issues between point A and B (*see Figure 5.3.1*). Bank slumping occurred in this location as a result of incorrect water levels in the design. Boulders were put in above this section to increase the water levels and this has reduced the slumping. These remediation works cost approximately £10,000. The longitudinal profile has remained stable with no significant morphological adjustment. In addition a greater variation in flow characteristics has been observed compared to the previously very uniform condition. Both factors indicate the success of the scheme.

Fisheries monitoring has demonstrated an improvement in salmonid recruitment. In particular a significant increase in the density of Atlantic salmon (*Salmo salar*) fry has been recorded (*see Figure 5.3.5*). Whilst continued monitoring of fish has been undertaken, no other ecological data has been surveyed in relation to this scheme. Fencing has been installed on the right bank and this has now vegetated up as a result.

Figure 5.3.5
Fisheries data showing a significant increase in the density of Salmon fry following the restoration works in 1998. No data post 2009



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Restored bed levels and bank profile.
Right bank vegetated as a result of fencing.
November 2012.

Contacts

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