Afon Eigiau and Llyn Eigiau - Dolgarrog

An advisory visit carried out by the Wild Trout Trust – June 13th 2013

1. Introduction

This report is the output of a Wild Trout Trust Advisory Visit (AV) undertaken around Llyn Eigiau and the reaches of the Afon Eigiau directly upstream of the lake. The river valley was inspected between National Grid reference (NGR) SH 72108 64900 and NGR SH 71624 63684.
The visit was hosted by Mr. Pierino Algieri of Natural Resources Wales and Mr. Peter Jones, secretary of Dolgarrog Fishing Club. Comments in this report are based on observations and discussions on the day of the site visit; which was prompted by the current absence of larger (2-lb) trout that were, historically, captured in the Afon Eigiau. Additional information on the history of the reservoir was also obtained from open-access internet resources.

Throughout the report, normal convention is followed with respect to bank identification i.e. banks are designated Left Bank (LB) or Right Bank (RB) whilst looking downstream.

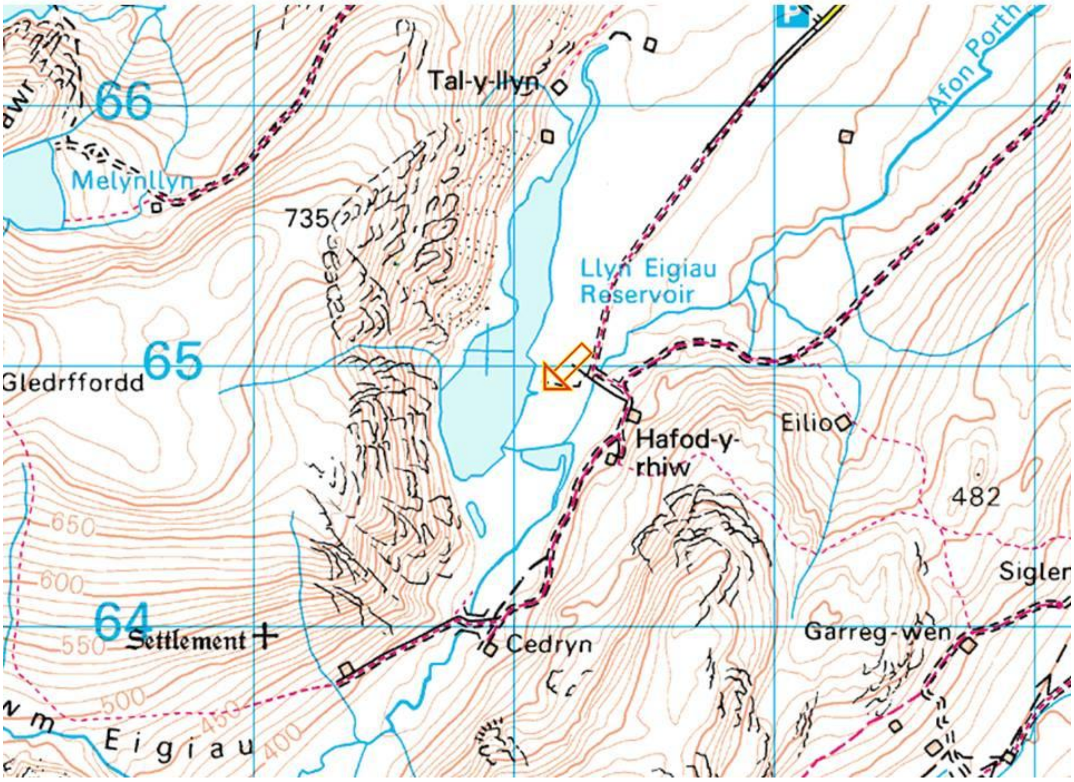

Figure 1: Map of the lake with the upstream river system to the south of the stillwater. Arrow is at NGR SH 72108 64900

2. Catchment overview

The name Eigiau is thought to be an ancient derivation of a term referring to the shoals of fish which once lived here. A small number of Arctic char are suggested to have existed in the lake following their transfer from Llyn Peris. In 1911 a dam ¾ mile long and 35-feet high was built across part of its eastern side to supply water for the power station at Dolgarrog, which in turn provided power for the adjacent aluminium works. The original contractor pulled out of the construction, alleging corner-cutting. Subsequently, on 2 November 1925, following 26 inches of rain in just five days, the dam broke. The water flowed down to Coedty reservoir, also causing that to burst, and millions of gallons of water flowed down into the village of Dolgarrog, causing the loss of 17 lives. A new power station was built at Dolgarrog in 1925.

Today the lake covers an area of about 120 acres, and has a depth of about 32-feet. After the construction of the dam its area would have been increased to approximately 240 acres.

Water is fed into Llyn Eigiau by a tunnel from the stream below Llyn Dulyn, and another larger tunnel takes water from Llyn Eigiau to Llyn Cowlyd. The vertical-head-difference between the lake waterbodies is used to generate hydro-elecric power in Dolgarrog, and, as such, is a very long-standing modification to the natural hydrology of the system.

The Afon Eigiau is the main feeder of Llyn Eigiau; flowing down Cwm Eigiau to feed the lake via a complex of wetland rivulets at the lake's south-eastern corner.

The outflow from Llyn Eigiau is called Afon Porth-llwyd, and this flows via Coedty reservoir before passing under Pont Newydd in Dolgarrog. This then flows into the River Conwy.

Although the Afon Eigiau itself does not have a separate WFD waterbody classification, it fundamentally influences the Ecological Potential of Llyn Eigiau (waterbody GB 31033571; Table 1).

Table 1: Summary designations for Llyn Eigiau under Water Framework Directive waterbody classification

Llyn Eigiau Reservoir	
Water Body Name	Llyn Eigiau Reservoir
Water Body ID	GB31033571
Management Catchment	Conwy and Clwyd
River Basin District	Western Wales
Typology Description	Low Alkalinity, Very Shallow
Hydromorphological Status	Heavily Modified
Current Ecological Quality	Moderate Potential
Current Chemical Quality	Does Not Require Assessment
2015 Predicted Ecological Quality	Moderate Potential
2015 Predicted Chemical Quality	Does Not Require Assessment
Overall Risk	At Risk
Protected Area	Yes
Number of Measures Listed (waterbody level only)	0

3. Habitat assessment

The first feature inspected was the draw-off outlet for hydro-electric generation at SH 72108 64900 (Fig. 2). Since the failure (and subsequent additional dismantling) of the dam, these sluice gates now exert the principle control on the level of water in the lake. Whilst the original damming would have artificially raised water levels, it is locally-believed that the current operation of the sluices impacts on the ecology of the lake. The protocol for the transfer of water imposes a heavily-regulated pattern of water level and, consequently, littoral (shore-line) wetting and drying regime.

Figure 2: Draw-off point for transferring water and associated hydro-electricity generation

Naturally, a generally-reduced water level provides a smaller habitat resource for those adult trout that the angling club targets within the lake. Because of the complexity of natural systems, it is very difficult to predict the impact of changes in both the average (mean) wetted area and the way that those levels vary around that mean value. At the time of the visit, it was also unclear as to whether there were provisions to prevent fish entering the water-transfer pipe system – and being impacted more directly. The situation is further complicated by the existence of historic legislation enabling the operation of water transfer facilities for the purposes of power generation. However, as the lake itself constitutes an "at risk" waterbody under the European Water Framework Directive legislation, there may be interesting legal contests to decide which elements of which particular legal statutes take precedence.

A further potential impact of reduced water levels may be acting on the ability and motivation for larger adult trout to migrate into the Afon Eigiau. The hydrological connection between the lake and the river was relatively indistinct - despite the rainfall that had immediately preceded the site visit (Fig. 3).

Figure 3: Afon Eigiau entering Llyn Eigiau via a diffuse network of vegetated channels

Members of the Dolgarrog angling club previously report captures of larger trout in the river system that are now no longer seen. Given the relatively small size of the river, this phenomenon could be consistent with a life-history similar to that exhibited by "dollaghan" trout in Ireland. In other words, fish growing to increased adult sizes within a lake habitat and re-entering the river system in order to spawn. Although the breeding and associated migration urge is incredibly powerful in brown trout, a reduced success rate in entering the feeder stream cannot be ruled out (either by reduced window of migration opportunity or increased predation impacts during delays).

With a reduced wetted-area and the further modification of water transfer e.g. via construction of a new bypass channel (Fig. 4), it is possible that fish may have a less clear "signal" to aid in the location of the feeder stream. There may also be a reduction in the availability of any shoreline gravel spawning that can be supported by wave-action. At the same time, it is unclear as to how water-level changes will also interact with changes in the overall productivity of the lake. The majority of the previously wetted area would have consisted of extensive shallows. Due to improved sunlight penetration, these are always the most productive areas of upland lakes. Consequently, the most productive areas of the lake (in terms of plant-life, invertebrates and fry) would be lost following a reduced water level. This could impose a significant limitation on both the numbers and size of trout that can be supported. This factor, alone, would mean that reducing the total area of the lake is likely to have had a disproportionate effect on trout productivity. As a simple example, halving the area of the lake could easily reduce the population of large trout by much more than half. This is easy to understand when nearly all of the "lost" area consists of productive shallows. By contrast, the remaining water consists of a more even split of both deeper refuge (also a vital habitat component) and a comparatively small area of shallow bays. On top of this, if there is even a small additional effect of either reduced spawning access or fish lost to the water-transfer system, the compounded effects could cause an effect that is greater than the sum of each individual part.

Figure 4: Recently-constructed bypass channel serving the hydropower system: a further complication for fish migration due to controlling influence on water levels and connectivity between the river and the lake. It is also very poor trout habitat.

Habitat within the river channel (Fig. 5) can be characterised as supporting features such as a meandering plan-form, riffles and lateral scour pools (deposition of gravels on the inside of bends and noticeable increases in depth on the outside of bends).

Figure 5: The river displays a meandering plan-form and there is quite a good degree of variation in depth, current velocity and cross-sectional profile evident. There is, though, little or no cover for fish.

However, the bed material consists almost entirely of mobile gravels between approximately 20 mm and 50 mm in diameter. In addition, although the levels of grazing stock are relatively low, there is no succession of woody vegetation and there are examples of “block failure” of riverbanks (Fig. 6)

Figure 6: The lack of deep root structure (prevented from developing due to even comparatively light grazing at this elevation) is compounding an over-abundance of gravels by promoting low resistance in the riverbanks. Tussocks of grass in the channel (right of frame) and behind the corrugated iron revetment (upper left/middle of frame) indicate that the rate of bank erosion is too fast.

Efforts to slow this process by installing vertical sheets of corrugated metal (Figs. 6 and 7) will make the bank erosion worse immediately downstream (Fig. 6). The metal sheets are, ultimately, not effective at slowing erosion at the point that they are installed; inhibiting plant growth and exposing a vertical face of bare soil once corroded. Such flat and angular structures also increase the average pace of current – as well as promoting strong eddying flows during spate conditions. Both of these factors result in worse erosion of the banks, widening of the channel and further inputs of soil and gravels into the stream.

Whilst the generally shallow conditions are likely to be favourable for juvenile trout, the lack of variation from these conditions will be limiting its value to older trout – as well as to invertebrate and plant species. You can always have too much of a good thing. The likelihood is that any successfully-hatched young trout will quite quickly outgrow the habitat and food supply available in the stream – and will need to transfer to the lake in order to achieve better growth and survival (where the marginal habitats may be compromised by level fluctuations).

Figure 7: Sheet metal revetment (centre of frame) designed to protect the bank – but clearly causing worse erosion immediately next to it (right of frame)

The conditions in the sections of river detailed in this report are evident right up to the points at which the steep mountain-side streams join together in the valley-bottom to form the main Afon Eigiau. As a result, there is an excess of juvenile habitat and a lack of adult habitat – as well as an over-supply of gravel to the stream bed; increasing the bed mobility and the chances of egg/alevin wash-out.

The overall productivity of the stream would, consequently, increase if additional physical variety could raise the foodweb biomass and provide a wider variety of opportunities for aquatic life. The key, though, would be to avoid exchanging one set of uniform conditions for another set of "alternative-but-equally-uniform" conditions. See recommendations (section 4) for suggestions on how to go about this.

There is a great complexity of interacting effects within the Eigiau stream and lake system. This is reflected in the lack of certainty surrounding just how much of a barrier there is to migration from the lake into the river. As a consequence, it is currently unclear how much benefit could be gained from designing and constructing a "self-cleaning" channel connection between the lake and the river. Conversely, there are multiple potential benefits that could be gained from an increase in water level within the lake – including improved connectivity (section 4 provides more details).

4. Recommendations

4.1 Summary recommendations

- Explore the potential to raise average water levels within the lake with the hydropower operators as a key first step that would offer the following benefits:

    - Increased productivity within the lake system – and an associated benefit to wild fish populations
    - Increased duration of opportunity and general potential for free migration between lake and river (providing more resilient wild trout population dynamics)

- Explore the potential for effective screening (if not in place already) of juvenile and adult fish to prevent entry into the water-transfer system
- Establish a trial section of grazing-exclusion and tree planting – with a view to expanding and providing further, comparable grazing exclusion buffer zones along the Afon Eigiau (see details below)

4.2 Buffer-zone creation for adult trout habitat and river-corridor productivity improvement

4.2.1 Benefits to trout stream ecology

Although current grazing stock levels are relatively low, there would be significant benefits to both physical habitat structure *and* productivity that would accrue from creating sections of well-vegetated river bank. As well as providing natural narrowing and greater erosion-resistance (and associated increase in depth) of the river channel, the development of deeper root systems and overhanging canopy would contribute significantly to better "cover" for adult and juvenile trout. The increased resistance of the banks may also act to reduce some of the over-supply of gravel to the river bed.

In addition, the establishment of a varied understory and higher tree-canopy would provide significantly increased "subsidies" to the aquatic food chain of the river. Both increased amounts of leaf litter (used as a food source by many aquatic invertebrates) and increased numbers of "crash landings" by terrestrial invertebrates will result in an increase in prey abundance for trout. The combination of increased food, increased depth and increased cover will significantly increase the value of that section of river to adult trout. This would add greater resilience to breeding populations by offering additional life-history options - i.e. trout would not be saddled with the single option of having to continually transfer between lake and river in order to grow to adulthood.

The ultimate increase in the supply of stable woody debris to the river would also improve spawning success by grading gravels into mounds made of similarly-sized particles – as well as keeping those gravels free of fine silt that can suffocate incubating eggs. Further cover for both adult and juvenile trout would also be generated by timber in the stream.

4.2.2 Benefits to farming

As well as the potential for the river-improvement works to fund the installation of fencing required to establish vegetated buffer zones – there may also be advantages from an animal-husbandry perspective. Much of the land directly adjacent to the Afon Eigiau is very boggy and relatively poor for grazing. In addition, there may be greater potential for livestock to become stranded in those areas. Engaging in land-management works such as this may also make farmers eligible for "Tir Gofal" stewardship schemes: http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000IL3890W.16NTBX3KH70109. There may also be valuable input available from Coed Cymru that could help support planting schemes (http://www.coedcymru.org.uk/). The potential benefits to animal health as well as flood risk and erosion problems of tree planting schemes have been well demonstrated in, for example, the Pont Bren project: http://www.pontbrenfarmers.co.uk/research.html. The project has demonstrated dual benefits (e.g. increased animal welfare due to the establishment of deciduous "shelter belts" as well as increased ground penetration of rainfall) to both farming and environmental concerns.

4.2.3 Guidance on creating vegetated buffer zones

In order to preserve existing good conditions for juvenile trout, it is recommended that grazing exclusions are created in a "patchwork" fashion along the Afon Eigiau. This would result in sections of both shallow/wider/more gently-flowing juvenile habitat as well as deeper/stronger current-flow/greater large structural cover for adult fish. As a benchmark suggestion, sections in the region of 80 to 100 –m in length could be fenced off – with comparable unfenced lengths between each exclusion. As previously suggested, an individual trial "fenced" section may be an appropriate way of demonstrating the principle to both the farming and fishing communities. A summary of considerations is given below:

- If possible, buffer zones would be at least 5 and 8 metres (ideally more) wide – because this gives:
  - good scope for varied vegetation/canopy development and succession
  - Room for the river to move laterally during the establishment of deeper root systems
- Narrower buffer zones down to around 3 m wide *may* be possible to establish, but these would require additional secure brash installation within the channel in order to reduce lateral river-channel movement during the time taken for deep root systems to become established
- Supportive planting of trees within the grazing exclusion would greatly enhance the development of good river-side vegetation. Tree species should be selected that are appropriate to the conditions, aspect and context of each site (willow species, hawthorn and alder may be appropriate candidates for the Eigiau)
- Broadleaf deciduous species will offer the greatest benefit in terms of increased productivity – due to the greater nutritional value of their leaf-litter compared to coniferous species
- The use of well-anchored "water gates" (Fig. 8) at both ends of a grazing exclusion offer a good insurance against changing water levels that may,

otherwise, allow grazing animals to get inside the exclosure area and negate the value of any fencing project

- The presence of both fenced and unfenced areas will also retain the provision of access to drinking water for grazing stock (as well as retaining "nursery" habitat for juvenile trout).
- Fencing that is parallel to the flow of the river tend to remain largely undamaged by out-of-bank spate flows; whereas the installation of sacrificial "breakaway" panels (or even top-hung panels; Fig. 8) that are orientated at right angles to the flow can reduce maintenance requirements following flooding

Figure 8: Example of top-hung water gates that would be required at each end of a grazing exclusion. Fencing panels that are orientated at 90-degrees to the river could also be installed in a similar fashion to prevent damage during out-of bank spate flows (or the use of loosely-tacked fencing panels that will break away during floods, and be easily replaced, can be a viable alternative)

It is a legal requirement that some works to the river may require written Natural Resources Wales consent prior to undertaking those works, either in-channel or within 8 metres of the bank. Any modifications to hard defences will require a land drainage consent on any river designated as "main river". Advice can be obtained from the local Development Control Officer. The ownership of the land and its management for a means of electricity generation and farming will also

carry specific requirements to obtain all relevant permissions for any works that may impact on those operations

5. Making it happen

There is the possibility that the WTT could help to start a project via a Project Proposal (PP) or a Practical Visit (PV). PV's typically comprise a 1-3 day visit where approved WTT 'Wet-Work' experts will complete a demonstration on the site to be restored. This will enable fishery managers to obtain on the ground training regarding the appropriate techniques and materials required to enhance trout habitat. This will then give projects the strongest possible start leading to successful completion of aims and objectives.

Recipients will be expected to cover travel and accommodation expenses (if required) of the PV leader.

There is currently a big demand for practical assistance and the WTT has to prioritise exactly where it can deploy its limited resources. The Trust is always available to provide free advice and help to organisations and landowners through guidance and linking them up with others that have had experience in improving river habitat.

Acknowledgement

The WTT would like to thank the Environment Agency for supporting the advisory and practical visit programmes.

Disclaimer

This report is produced for guidance and not for specific advice; no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting, upon guidance made in this report.