Pen-Y-fan Pond, Pentwyn Crumlin, Caerphilly

An Advisory Visit by the Wild Trout Trust May 2015

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Introduction

This report is the output of a Wild Trout Trust visit undertaken by Mike Blackmore on Pen-y-fan Pond, near Pentwyn Crumlin, Caerphilly (national grid reference (NGR) SO 196 005). A walk-over of the site was requested by Mr Bill Gutteridge, who as a committee member represents Islwyn and District Anglers, whilst accompanied by James Bower, Caerphilly Country Parks Ranger. The visit was primarily focussed on assessing habitat for wild trout (*Salmo trutta*) and identifying opportunities to enhance the lake and its feeder stream to better support the resident brown trout population.

Comments in this report are based on observations on the day of the site visit and discussions with Mr Gutteridge. 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.

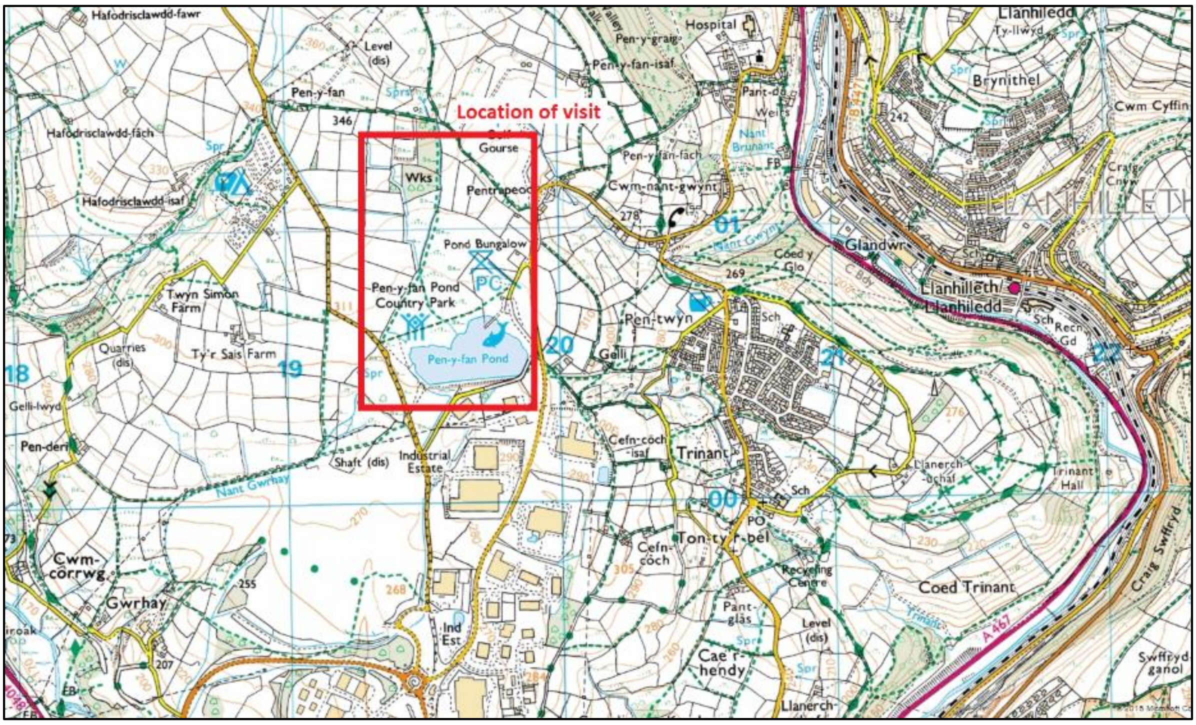


Figure 1: Map showing the location of Pen-y-fan Pond and the stream that feeds it

Catchment and Fishery Overview

Pen-y-fan Pond is a man-made reservoir that was originally built to feed the eastern branch of the (now decommissioned) Brecon Monmouthshire Canal, and is one of the last remaining canal feeder reservoirs in Wales. The reservoir is owned by the local authority and is listed as an ancient monument. It is presently operated as a country park lake and has a surfaced footpath around its perimeter. The lake is approximately 6.7 hectares (14 acres) in area and is primarily used for fishing and kayaking.

The underlying geology of the area consists predominantly of sandstone overlain with till (sediments laid down by glacial ice), resulting in deposits of clay and gravel within the catchment. Whilst the glacial deposits are responsible for the presence of suitable spawning substrate within the lake's feeder stream, the underlying sandstone from which the spring rises accounts, in part, for the fine, sandy sediment observed at the stream mouth by Mr Gutteridge and other club anglers.

Although the lake is stocked with rainbow trout (*Oncorhynchus mykiss*), it also supports a native breeding population of wild brown trout (*Salmo trutta*). Mr Gutteridge and Islwyn Anglers are concerned that siltation around the mouth of the feeder stream and the quality of habitat in the stream itself may be a limiting factor on the health and abundance of the wild trout population. Mr Gutteridge also raised Islwyn & District Anglers concerns over the impact of predation from increasing numbers of cormorants (*Phalacrocorax carbo*).

Habitat Assessment

For the purposes of this report, the water visited will be described from the upstream extent of the visit, downstream to the dam.

At the upstream extent, the stream flows over a small dry-stone weir (Figure 2) before being diverted under a country lane via a narrow culvert. At present, this is as far upstream as fish can migrate from the lake. The weir is a complete barrier to fish passage but considering this is very close to the source of the stream, there would be limited benefit in improving fish passage at this location.

From here, the stream flows southwards through woodland, towards the lake, in a steep gully with a gravel and cobble bed (Figure 3). The channel has, at some point, been artificially straightened, leaving it uniformly trapezoidal in cross section. Fortunately, the steep gradient and an abundance of woody debris in the channel means that scouring flows act upon the stream bed during the wetter months of the year. This helps to retain a relatively uneven bed thus creating a moderately diverse habitat.

Scouring flows acting on the bed, particularly when deflected by large stones, woody debris or roots, helps to wash away fine sediment and naturally 'sort' gravel. This process improves the quality of spawning habitat, ensuring that gravel is less compacted and making it easier for trout to cut their redds. It also helps to ensure that the eggs and alevins within the interstices between gravel grains remain well-oxygenated and free from fine sediment until they have used up their yolk supply and emerge as fry.

Naturally meandering streams promote a greater diversity of flow conditions, providing a greater diversity of depths as well as introducing additional gravel into the system through lateral erosion. As a general rule of thumb, the greater the abundance and diversity of physical features within any given stream, the greater the abundance and diversity of biological niches available. This is especially important for trout which rely heavily on river biodiversity to provide prey, such as freshwater invertebrates, throughout the year. Trout populations also require a wide range of different habitats to fulfil different needs at various different life stages.

In the case of Pen-y-fan Pond, the stream provides the only spawning and nursery habitat, whilst the lake provides habitat for parr and adults. The very bottom reaches of the stream may also provide some refuge habitat for parr but for the vast majority of its length, the stream is too small, holding insufficient depth of water, to support any fish larger than fry for any prolonged period of time.

Figure 2: A dry-stone weir near the source of the feeder stream is the upstream limit for trout migration

Figure 3: The stream is straightened and uniformly trapezoidal in cross section. It does however, retain a relatively diverse bed morphology.

At NGR SO 19568 01197, an overflow outfall from nearby water storage tank was observed (Figure 4). No sign of nutrient enrichment were observed and other than possibly contributing to the flashiness of spate flows, the outfall does not appear to have any observable impact the stream.

Figure 4: The outfall pipe at SO 19568 01197 showed no signs of nutrient enrichment (pollution) such as algae or sewage fungus

From the outfall downstream, the LB remains wooded but the RB opens out into an arable field (Figure 5). Intensive arable farmland is very often a diffuse source of excess fine sediment. Fortunately, there is a wide buffer strip of grass between the stream and the cultivated area of the field. This buffer will provide a certain degree of filtering of surface water run-off, helping reduce the fine sediment input to the stream.

The wooded valley casts dappled shade over most of the stream and shade plays an important role in regulating temperature in rivers. In small headwater streams this function is especially important as low flows during periods of prolonged dry weather can leave many temperature-sensitive species of fish and invertebrates vulnerable; not only does warmer water contain lower concentrations of dissolved oxygen, but it can also increase the effect of pollutants and the susceptibility of trout to a range of pathogens. Although salmonids are able to acclimate somewhat to different average temperatures; one week at 25^{O}C, or only 16 minutes at 27^{O}C will be lethal to brown trout. Any temperature above 19.5°C will severely stress trout, potentially threatening long-term survival.

Temperature also regulates the incubation period for trout eggs (100 days at 5°C or 50 days at 10°C) and the period in which alevins consume their yolk sack (~38 days at 7.5°C).

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291742/scho1008boue-e-e.pdf

Figure 5: The wide buffer between the stream and the land in arable cultivation may be helping to reduce the volume of fine sediment entering the stream

Tree cover also provides another vital function in headwater streams; fallen leaves provide the primary energy input for the stream ecology. Lower in the catchment, where flows are more stable, primary production is predominantly undertaken by aquatic and marginal plants. However, headwaters and steep-gradient rivers often cannot support large aquatic plant communities. Here, bacteria and invertebrates breaking down trapped leaf litter provide the base of the ecosystem's food chain.

Although essential to the ecosystem, leaf litter can contribute to sedimentation. River headwaters often have relatively clean beds as the number of fine sediment pathways into the stream should be relatively few. However, on the day of the visit, a visibly high volume of fine sediment was observed. There are many factors that contribute to the fine sediment loading of a stream. In this particular case, local geology, the farm track near the source of the stream and perhaps the arable field along its course are probably of greatest significance. Fortunately, the gradient, diverse bed morphology and the reportedly high winter flows (Mr Gutteridge Pers. Comm.) suggest that the stream probably receives sufficient flow during winter spawning/incubation season to scour fine sediment from the bed.

Along this reach a number of trout fry were observed darting amongst the submerged cover (Figure 6).

Figure 6: A trout fry (centre of image) camouflages well with its surrounding environment

The fry appeared to be in good condition and were present in surprisingly high numbers, especially where pockets of deeper water containing large cobbles, submerged woody debris and/or overhanging vegetation were present (Figure 7.)

Figure 7: Large cobbles and woody debris help to create a mosaic of micro-habitats for trout fry

At the downstream extent of the arable field, an area of deposition, possibly correlating to a brief change in slope gradient, has smothered the stream bed in fine sediment. In this particular location, allowing more sunlight onto the stream could be beneficial. Encouraging plant growth here will help to stabilise the silty berm that has formed and will help to better define the channel and promote scour during sufficiently high flows.

Figure 8: A little more sunlight to promote plant growth could help consolidate fine sediment in this location

The next field downstream is used as a training paddock for horses. This is a particularly low-impact land use which is very unlikely to have any negative effects on the health of the stream. Beyond the training paddock the stream crosses into a field grazed by cattle. The impact of the change of land use is immediately apparent and the quality of the stream is significantly degraded by bank poaching (trampling).

At the upstream boundary of the grazed field, a wide pool was found to be teeming with trout fry (Figure 9). This particular part of the field, having both shade and water, appeared to be also favoured by the cattle (Figure 10). Bank poaching can be extremely damaging to small streams and represents a significant point-source of excess fine sediment into the system. Grazing also reduces marginal biodiversity, resulting in a monoculture of shallow-rooted grass (which provides less underground structure for bank stability), and prevents the establishment of bankside saplings (which would provide essential instream cover).

Figure 9: A cattle-poached bay was teeming with trout fry


Figure 10: The combination of shade and water makes this a favoured congregation spot for cattle

The section of the stream flowing through the grazed pasture has a gravel bed and could be a potential spawning habitat. However, soil and fine sediment from the trampled banks is smothering the bed. Fencing off the stream to provide an un-grazed buffer of at least 2 metres either side would substantially improve this reach. Alternative methods for watering livestock are discussed in the *Recommendations* section of this report. Figures 11 and 12 highlight the impact of cattle grazing.


Figure 11: The cattle poached (trampled) banks represent a significant point source of fine sediment.

Figure 12: Cattle poaching is seriously damaging a small and fragile spawning stream

Whilst the upper reaches of the stream probably benefit more from the shade and leaf litter provided by the dense tree cover, this reach is less steep and could support a range of marginal wetland plants. This would provide valuable habitat for the adult life-stages of a variety of freshwater fly life, in turn providing prey for juvenile and adult trout. However, some shade from new sapling growth would be beneficial.

Along with the poor condition of the stream in this reach, the wild trout population has been put at further risk by the recent installation of a crossing in the form of an undersized culvert (Figure 13). The narrow aperture of the culvert means that, during higher flows, it will require a prolonged burst of considerable physical exertion from any fish attempting to pass through it upstream; the velocities and duration required may even be above the swimming capabilities of most trout. The narrow pipe is also at a substantial risk of becoming blocked which would result in the stream flowing over the crossing in a diffuse manner; this would further hinder upstream migration and cause erosion leading to more sediment ingress to the stream. The culvert should be removed and replaced with something more appropriate, such as a clear-span bridge or much larger, sunken culvert, as a matter of priority.

Figure 13: The culvert at this crossing is a significant obstacle to fish passage and should be replaced as a matter of urgency

After a few more metres, the stream enters the grounds surrounding the lake. Almost immediately it is forced though another culvert below a surfaced footpath (Figure 14). This latter culvert appears to have been recently installed (or refurbished). As with the crossing upstream, the aperture of the pipe is less than ideal for fish passage. The narrow diameter also means the culvert risks becoming blocked and flooding the footpath. The pipe is also perched above the river bed and has a large flat apron (creating very shallow water), both of which further hinder fish passage. Ideally this should be replaced with a wider diameter culvert or clear-span bridge but it is understood that since the footpath has only recently been refurbished, other options may have to be explored in the short-medium term.

The remaining section of the stream flows through dense scrubland towards the lake. The sections of the stream that were accessible in this reach appeared to be in good condition with plenty of depth and cover. It is worth noting that this lower reach of the stream is unlikely to provide spawning habitat as the gradient of the bed is reduced and flow is backed-up by the water level in the lake. What is important in this reach is that trout can safely traverse upstream without becoming too vulnerable to predators such as piscivorous birds.

Figure 14: Another narrow culvert is another major obstacle

Figure 15: Towards the mouth of the stream, marginal vegetation providing important cover is in greater abundance

The wetland plants around the mouth of the stream provide a valuable boost to biodiversity. This habitat is an important component of the lake ecosystem and should be conserved wherever possible. However, as with most 'online' lakes (connected to a river), the sudden drop in flow speed at the mouth of the feeder stream allows sediment to drop out of suspension and accumulate on the bed. This process causes the lake to shallow around the mouth, becoming colonised by wetland species as the open water habitat is steadily replaced by emergent marginal habitat. When considering options for de-silting the stream mouth, it is important to strike a balance between retaining water depth and marginal biodiversity. When dredging this part of the lake, retaining a gentle slope up to the vegetated bank will ensure that a succession of different plant species, favouring different levels of saturation, will continue to flourish.

Figure 16: Fine sediment drops out of suspension and deposits on the bed of the lake near the stream mouth

A cursory examination of the sediment accumulating around the stream mouth suggests that a large proportion of the sediment is inorganic (sand). It is therefore unlikely that silt treatments based upon stimulating bacterial decomposition, such as treating with porous calcium carbonate (Siltex), will have a significant effect. Mechanical removal such as via systems that pump silt/sand through large, permeable geotextile bags positioned on the upper bank will probably deliver the best results. These systems allow filtered water to drain back into the lake whilst the fine material trapped in the bags slowly dries. There are a number of specialist companies that provide this service and searching online for nearby contractors and inviting them to provide quotes will probably provide the best value for money. It should, however, be noted that the only sustainable, long-term solution is to reduce the sediment input from upstream.

Figure 17: The sediment has an organic component (darker material) but appears to be mostly inorganic, sandy material

The opposite (southern) bank consists of a hard-engineered dam wall providing virtually no marginal habitat or cover (Figure 18). Whilst rainbow trout are often comfortable patrolling the open water at a relatively shallow depth, brown trout, especially wild fish, prefer the cover of the margins or deeper water.

Figure 18: The dam wall end of the lake presents a bare and uniform marginal habitat

In a stocked lake environment, young parr dropping into the lake will rely heavily on the 'shaggy' marginal habitat provided by emergent plants, roots and fallen trees. This not only protects them from predation, but also allows a greater number of juvenile trout to occupy a certain area without feeling threatened by each-others presence. From the moment they emerge from the gravel, trout are territorial and do not remain within sight of each other if they can avoid it. Brown trout are also naturally photophobic, favouring overhead cover and shade. Dense, complex woody habitat in the form of fallen branches provide refuge from predators, an abundance of cover and plenty of visual barriers blocking the line of sight between individual fish.

The barren southern bank is mitigated somewhat by the wetland along most of the northern bank but in general there is a paucity of bankside trees around the lake. Near the outflow of the lake however, one small bankside willow (*Salix* sp.) had been recently felled and was awaiting removal by the Park Rangers (Figure 19).

Figure 19: An excellent, if not necessarily deliberate example of marginal habitat enhancement

Removal should be discouraged as this is exactly the type of habitat that should be retained and increased around the lake. A balance will have to be struck between habitat, facilitating angling, and the public-perception, but any increase in the abundance of this type of habitat will be beneficial.

http://www.therrc.co.uk/MOT/References/WT_Fish_live_in_trees_too.pdf

In a few locations around the lake, old redundant iron work structures protrude from the water, making convenient perches for cormorants. The fishing club has utilised an elegantly simple and effective solution to this problem consisting of branches tied to the iron work – and to any other would-be perches that prevent cormorants from landing on them (Figure 20). For cormorants, as with most predators, hunting efficiency in terms of energy exerted compared to calories gained, is of critical importance. Hence making fishing as difficult as possible for cormorants should encourage them to seek out easier meals elsewhere.

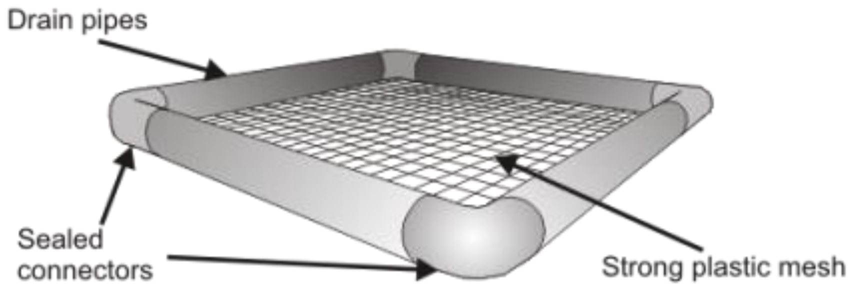
Figure 20: Simple branches tied to would-be cormorant perches act as excellent deterrents

This principle should be considered when planning any habitat enhancements around the lake (See *Recommendations* section).

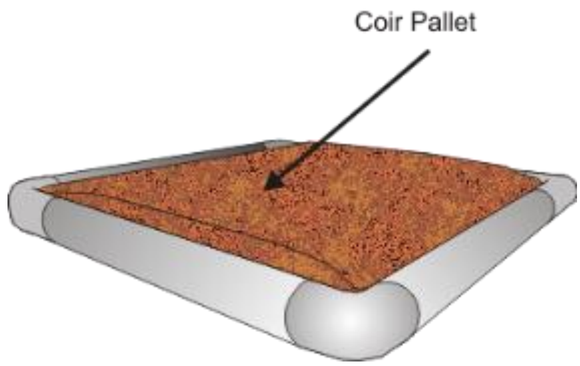
Increasing the abundance of marginal cover, such as from trailing willows, around the lake should be a priority habitat enhancement. However, additional cover could also be introduced in the form of floating islands. These come in a variety of different configurations and vary in price accordingly. At the high end of the market, modern, self-buoyant 'BioHaven' systems provide long-lasting low-maintenance habitats that provide excellent cover whilst also promoting natural plant and microbe processes that improve water quality and help control algal blooms. Cheaper floating islands can be purchased that may require a little more annual maintenance. Alternatively, floating islands can be home-made following on-line YouTube videos.

The basic design of a low-cost floating island is as follows:

Step1



Step 2



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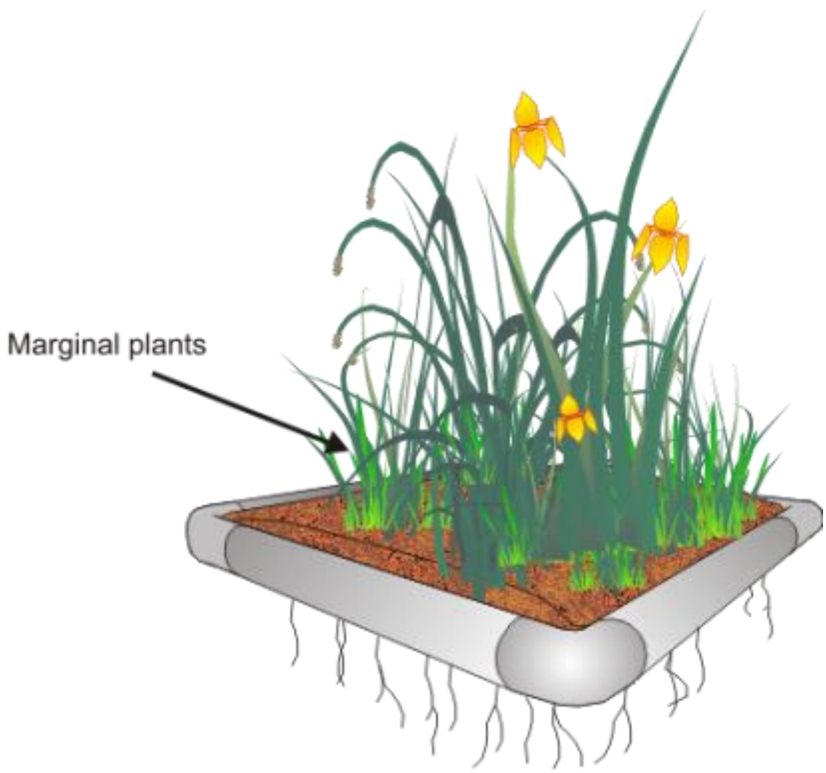

Figure 21: A simple step-by-step example of a DIY floating island

Floating islands can also be purchased equipped with suspended cages beneath them (Figure 22). These provide additional refuge from predation, further limiting the impact of cormorants, and larger predatory fish including cannibalistic trout.

Figure 22: Floating islands with suspended refuge cages

It is important to ensure that the islands are planted with species tolerant to the local conditions. Ideally, plants that are already present around the pond or lake in which they are installed.

During the visit Mr Gutteridge raised Islwyn and District Anglers concern over recent infestations of Canadian pondweed (*Elodea Canadensis*) and the best means of control. There are presently no officially approved chemical controls for *Elodea* and the best biological control is to stock infested lakes with enough bottom-feeding fish (such as grass carp) to increase turbidity to the point where the weed is deprived of light. In some cases, inert dyes have been used to produce the same effect. The most suitable method of control of Canadian pondweed at Pen-y-fan Pond is mechanical removal (cutting). This should be undertaken in March, possibly followed by repeat treatments later in the growing season to keep the weed at low-level. Although labour-intensive, this method will significantly weaken the plant and may lead to its eventual disappearance from the lake. http://nora.nerc.ac.uk/10424/3/N010424_leaflet.pdf

Conclusions:

In order to assess the fitness of wild trout habitat, one of the most important actions is to identify where any potential population 'bottlenecks' may be occurring (Figure 23). A population bottleneck occurs where a limiting factor, such as habitat quality, affects a particular life-stage, resulting in a reduction in overall population density. In the case of Pen-y-fan Pond, the lake provides abundant adult trout habitat but there is a relative scarcity of habitat for juveniles dropping in from upstream, creating a potential bottleneck at this life-stage. In addition, the degradation of the stream above the lake and obstacles to upstream migration are creating further, and potentially more severe bottlenecks in the spawning and fry life-stages of the resident brown trout population.

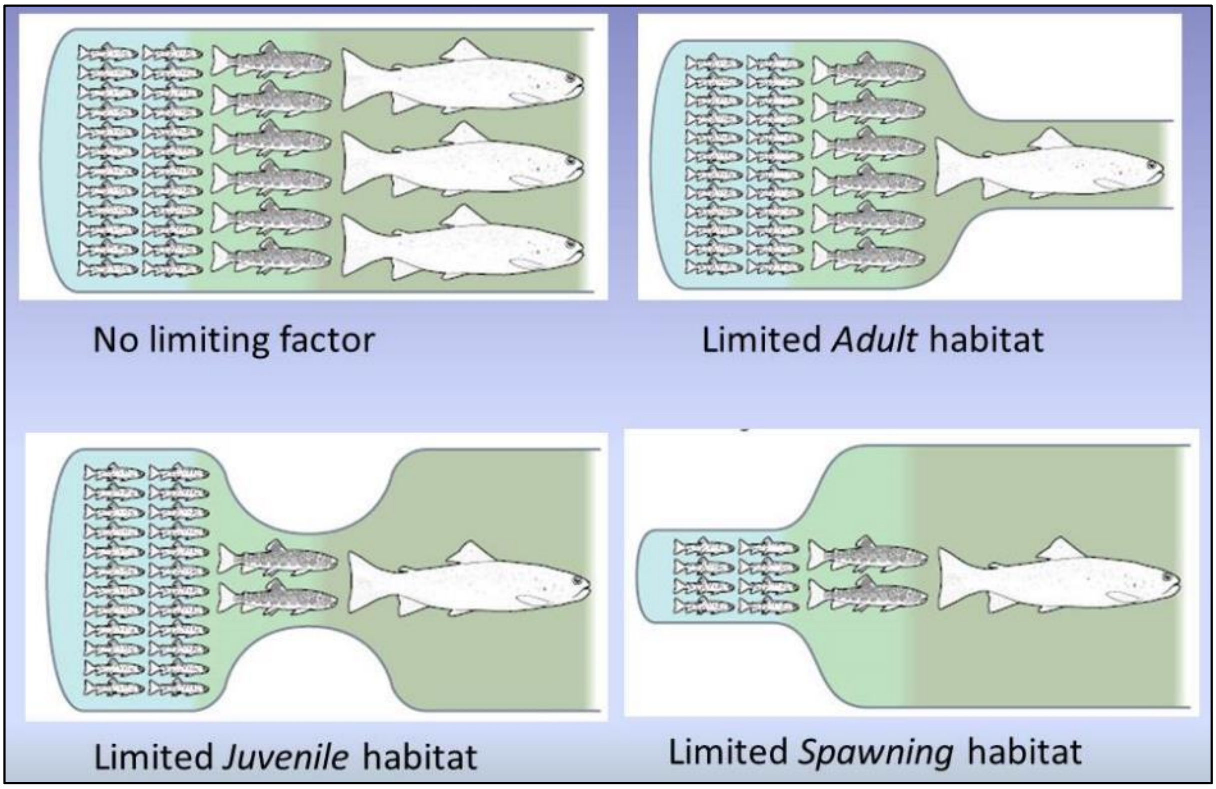

Figure 23: An illustration highlighting the basic principle of a population life-stage bottleneck

In order to safeguard, and improve the wild trout population at Pen-y-fan Pond, habitat enhancements and changes to land management are advised.

Recommendations

In order for Pen-y-fan Pond to achieve its full potential as a high quality habitat for wild brown trout, the following actions are recommended:

1. Engage with the land owner (Llanover Estates) and the tenant farmer to explore options for fencing off the stream in the field presently being grazed by cattle. Alternative means of watering livestock are available which can eliminate the need for cattle to access the stream entirely. Pasture pumps (Figure 24), for example, do not require electricity as they are simply powered by the cattle themselves.

Figure 24: A cattle-powered pasture pump in action

Protecting the stream through the field will be critical for the conservation of the Pen-y-fan wild trout population. Of equal importance is the replacement of the culvert in the field (Figure 13) with a clear-span bridge or at least a larger culvert.

Figure 25: An example of an appropriately sized culvert sunken to facilitate fish passage and natural sediment transport

Once the stream is protected from the cattle, occasional planting of small bankside trees would also be beneficial. Simply driving some live willow (ideally goat willow, *Salix caprea* or any other small shrub willow native to the area) whips into the bank in late autumn to early march, when the willow is dormant, should be sufficient for new saplings to establish.

2. A greater abundance of submerged, coarse woody cover habitat (branches) such as shown in Figure 19 should be introduced into the margins of the lake to provide additional refuge and cover habitat. Again, planting the shrub willow species in the lake margin will greatly improve the shade and protection available for fish (once they begin to trail into the water). As much cover as possible should be introduced near to the stream mouth in order to maximise protection for small parr first entering the lake. Explaining the purpose of such features to the general public by, for example, erecting some information boards explaining their purpose, will help lake visitors understand that they are a deliberate feature and not just 'untidiness'.

3. The bare concrete of the dam wall side of the reservoir could be softened by the installation of some marginal brushwood shelves (Figure 26). Securing brushwood into the margins of the dam wall would provide some

shaggy marginal refuge habitat for juvenile trout as well as habitat for freshwater invertebrates and marginal plants. These structures can be constructed using site-won woody material from scheduled tree works etc. However, it may be prudent to limit the amount of willow used as it is highly likely to sprout new growth, which will require a certain amount of annual maintenance. If brushwood cannot be sourced from other on-site tree species, it may be advisable to import hazel faggot bundles to undertake such works.

Figure 26: An example of a brushwood marginal shelf prior to planting. This was created by volunteers is just a few hours

A brushwood marginal shelf along the dam wall could be planted with marginal wetland species such as yellow flag iris (*Iris pseudacrorus*), rushes (*Juncus* spp.), and sedges (*Carex* spp.), greatly enhancing biodiversity and improving both terrestrial and aquatic fly life. It would also improve the general aesthetics of the lake, giving the dam wall a more natural, 'green' appearance.

4. Consider creating one or more floating islands on the lake. These would have a number of benefits including providing additional refuge habitat for trout and helping to regulate water quality. Once fully vegetated, they could also become attractive landscape features.

5. The culvert where the surfaced footpath crosses the stream (Figure 14) is also very narrow and perched, with a poorly passable shallow apron downstream. Although this has only recently been constructed, replacement with a clear-span bridge or larger culvert is a vital action to safeguard the future of fish stocks on the lake.

   As a short-term solution, fish passage through the culvert might be eased via the installation of a timber baulk pre-barrage downstream of the culvert. This would slightly raise water level in the culvert and help to baffle flow (Figure 25). It should, however, be noted that raising water level in the culvert is not an ideal solution for fish passage and could also slightly increase the frequency of events where flows exceed the capacity of the culvert, possibly increasing the frequency of flows over-topping the footpath. Replacing the culvert would be a much better long-term solution.

Figure 27: An illustration showing how a simple timber pre-barrage might look installed below the culvert outflow under the footpath

Making It Happen

The creation of any structures within most rivers or within 8m of the channel boundary normally requires formal consent from Natural Resources Wales. This enables the NRW to assess possible flood risk, and also any possible ecological impacts. However, stream headwaters are often not considered to be 'Main River' and are instead designated as 'Regular Waterbodies'. In this case, the local authority would have consenting powers. In any case, contacting NRW or the local authority early and informally discussing any proposed works is recommended as a means of efficiently processing an application.

Pen-y-fan Pond is an ancient monument under the care of Cadw, the Welsh government's historic environment service. Cadw will need to be consulted and permission gained for any works within the ancient monument boundary.

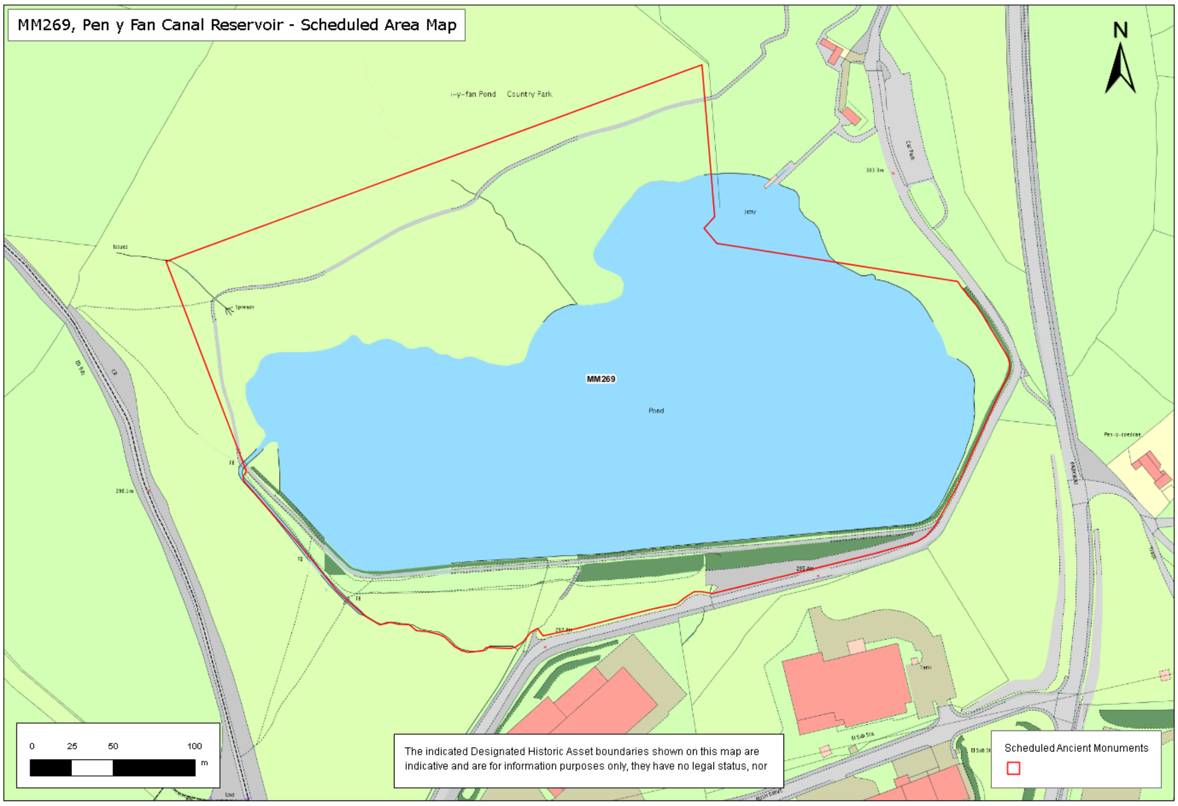

Figure 28: Map showing the boundary of the Cadw-controlled ancient monument

The WTT website library has a wide range of free materials in video and PDF format on habitat management and improvement:

http://www.wildtrout.org/content/index

The Wild Trout Trust has also produced a 70 minute DVD called 'Rivers: Working for Wild Trout' which graphically illustrates the challenges of managing river habitat for wild trout, with examples of good and poor habitat and practical demonstrations of habitat improvement. Additional sections of film cover key topics in greater depth, such as woody debris, enhancing fish stocks and managing invasive species.

The DVD is available to buy for £10.00 from our website shop http://www.wildtrout.org/product/rivers-working-wild-trout-dvd-0 or by calling the WTT office on 02392 570985.

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