Afon Machno: WFD waterbody GB110066054810Machno

Existing/historical information

Previous reports of thriving trout populations indicate that the potential should exist for good contemporary populations. However, the waterbody is currently indicated by the E.A. in Wales to be failing for trout abundance (based on electric fishing survey data). There are several impassable barriers (natural and man-made) downstream of inspected reaches – reducing the opportunity for recolonisation in the event that fish populations are severely depleted. The barriers also preclude any opportunity for anadromous fish recruitment.

During the site visit, a wealth of invaluable information was passed on by fisheries officer Pierino Algieri who also guided the visit to two reaches that captured typical features of the waterbody:

Reach 1 – lower section from woollen mill weir (which has a fish pass) at lower limit at National Grid Reference (NGR) SP 02145 80327 up to upper limit at NGR SH 79630 351517

Reach 2 – Upper section between lower limit of NGR SH 77273 48072 and upper limit at NGR SH 76232 47767

Spot checks were also undertaken en route between the two main reaches at SH78754 50614 (Afon Glasgwyn confluence with Machno), SH78685 49842 (Afon Machno) and SH78543 49529 (Afon Machno at Pont Oernant)

Bangor University are reported to have identified impacts of forestry on river in upper reaches. Land-use at headwater areas of catchment predominantly either forestry or heather moorland – though the main watercourse does not carry a peat stain in the visited reaches. Headwater tributaries soon give way to extensive grazed pasture (predominantly sheep) and seasonal silage production.

Much of the Right Hand Bank (RHB) is owned by National Trust, whereas the Left Hand Bank (LHB) is reported to be under more varied ownership. It is queried whether any specific previous incidents of pollution and impacts on trout and invertebrates are known.

Reach 1

Examples of good habitat in and around channel (e.g. Fig. 1), with some pool habitat present, good examples of suitable flow and depth for juvenile fish (in places combined with excellent partially submerged brashy/woody cover; e.g. Fig. 2) and substrate of a good potential size for spawning of both trout and salmon. However, there is potentially too much of a good thing, with an apparent oversupply of pebble and cobble-sized sediment (Figs. 1, 3 and 4). The value of gravels for spawning would also benefit from the presence of debris within the channel that would promote bed-scour and deposition processes that would help to “sort” particle sizes according to local current velocities. In addition, such debris would also increase the available cover for adult fish; improving the general value of habitat to resident adult fish – but also increasing the desirability and utility of adjacent spawning gravels.

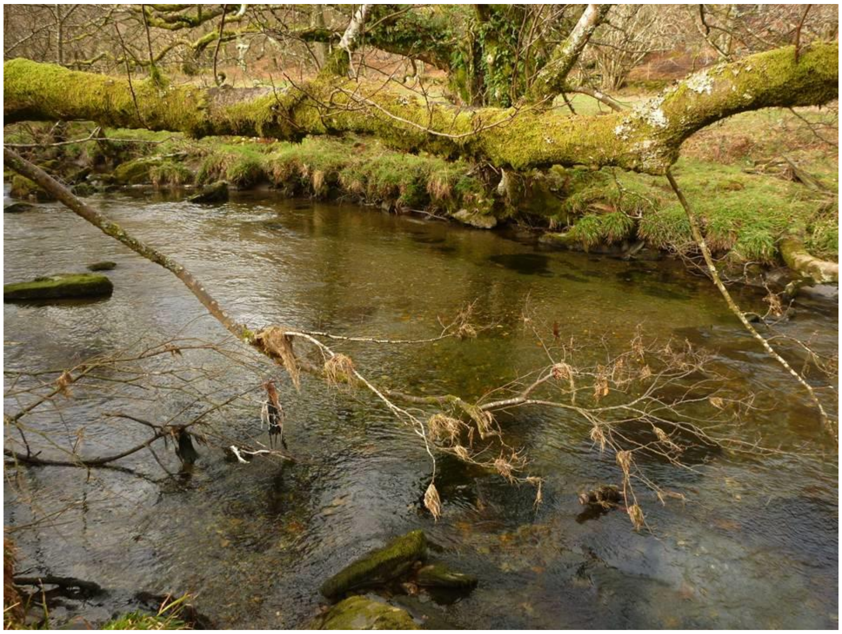

Figure 1: Crystal clear water with some nice submerged structure in the form of boulders. Opportunities for juvenile fish exist here along with some opportunity for adult fish (more areas of greater depth and more cover would increase prospects for adult fish). Far bank stone appears to have been laid deliberately by human hand – a common practice on the Machno.

Figure 2: Tremendous cover enhances the potential value of this riffle for juvenile fish. Although there are a number of examples of this type of habitat in this reach - there would ideally be a much greater proportion of similar areas and the grazing regime means that there is little prospect of a succession of such trees to replace the existing specimens (as seedlings will be grazed out).

Figure 3: Large gravel point bar on a heavily grazed bank (far bank). Channel consequently over-wide and over-shallow in a large proportion of this reach

Figure 4: Over-supply of cobbles evident on near bank (side bar), but good juvenile habitat is still present. However, adult fish habitat of equivalent quality was much less common due to lack of depth and cover in over-wide heavily grazed sections. Lack of scour-pool depth was often compounded by infilling effect of over-supplied substrate.

Figure 5: Planting and grazing exclusion scheme on riverside field (RHB). The LHB did not typically enjoy similar provision.

Figure 6: Grazed on both banks

Some fenced sections (not always on both banks) with vegetated buffer strip/trees (e.g. of varying degrees of grazing exclusion Figs. 1-4). There was also a short riverside field section that combined grazing exclusion with recent tree planting (Fig. 5). Conversely, also long sections grazed right to river's edge (e.g. Fig. 6). Generally, though, the channel was suffering from the effects of over-grazing.

There is known to be a great difficulty in making any economic (or any other beneficial factor) arguments to increase the amount of grazing exclusion from the riparian zone. Because of the very "flashy" nature of the catchment, out of bank spate flows are commonplace and this places a heavy burden of maintenance for any bank-side fencing (Fig. 7). Whilst grant schemes may pay for the fence installation, the resource required for maintenance is typically perceived as too great to be worthwhile.

Figure 7: The fencing just about survived the battering from a previous spate, but fences are frequently flattened during these events. Judging by the topography and the pattern of stranded debris, this is a point that floodwaters re-enter the river channel as water levels recede.

There were no apparent current problems with water quality based on invertebrates found in kick sample performed on site. Several taxa known to be sensitive to a range of pollutants including heavy metals, organic enrichment and pesticides were present. However, very low numbers of individuals were caught during a three minute sample. It was also noted that there was little evidence of leaf material retained in the channel or obvious periphyton (algae or diatoms) on much of the pebble substrate. Again, the highly variable, frequent and highly erosive spate flows are likely to remobilise what little deciduous leaf material falls into the channel as well as constantly disturbing and redistributing gravel and cobble substrate. A likely consequence is the poor retention of leaf litter and reduced opportunity for periphyton primary production (in what is already likely to be a nutrient-poor/low productivity stream).

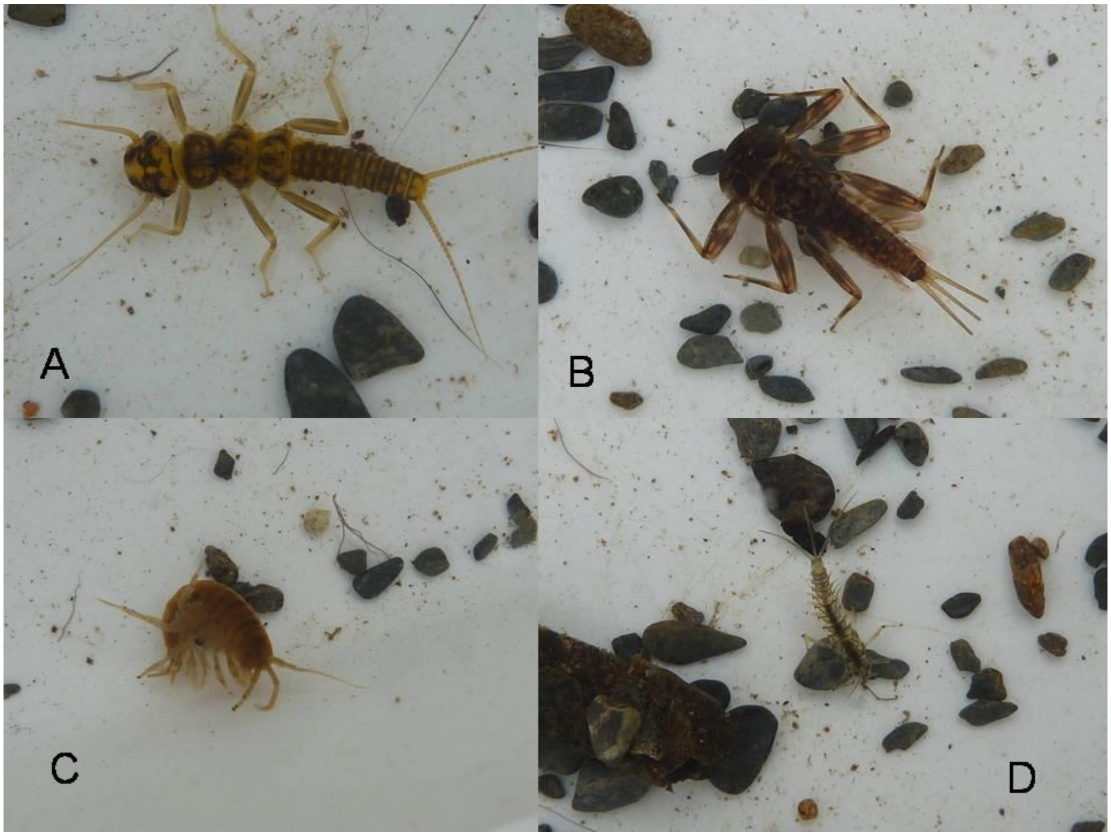

Figure 8: Invertebrate taxa that are sensitive to a range of pollutants were present in the Machno. These include species sensitive to organic pollution (A: Perlid stonefly, B: Heptageniid mayfly) as well as taxa sensitive to pesticides used in sheep dip (C: Gammarid shrimp) and taxa that can tolerate some organic pollution but are very sensitive to metal pollution (D: Baetid mayfly).

The finding that there does not seem to be a “toxicity” issue with respect to contemporary water quality is highly significant – as is the apparently low numbers of invertebrates supported by the stream. These points are discussed further with respect to Reach 2.

Reach 2

In general, the nature of impacts identified in Reach 1 also apply to Reach 2 (and in intervening sections that were “spot checked” en route; e.g. Figs. 9 and 10 between the two main Reaches that were walked). However, the extent and severity of these impacts was greater in Reach 2. Some additional stressors resulting from physical interventions in the river channel also compound the general effects. In particular, the practice of dredging shoals of cobble and gravel from the river and piling it on the bank top to form flood “bunds” (along with installing hard bank revetments constructed from large boulders) is also compounding the already highly erosive flow regime (Figs. 11 to 14 inclusive). These examples are characteristic of the section walked in Reach 2.

Figure 9: Grazing right up to riverbank and lack of both riparian deciduous trees and understory vegetation (Spot check en route at NGR SH 78685 49842)

Figure 10: Rapid lateral erosion and highly mobile bed substrate - a continually disturbed habitat. The rate of disturbance appears to be limiting nutrient retention and overall foodweb productivity (Spot check en route at NGR SH 78543 49529)


Figure 11: Dredged bed material piled up to form flood bund along the bank top in Reach 2


Figure 12: More substrate dredging and flood bund construction on LHB (left of frame) with hard revetment on RHB.

Figure 13: Detail of LHB bund and RHB hard boulder revetment

Figure 14: Where hard revetment runs out (and grazing occurs up to river's edge) the cycle of erosion continues at a rate that is harmful to fish populations and overall biodiversity

The major problem with the practice of dredging the riverbed and constructing hard/flow reflecting bank revetments is that it tends to increase the rate of erosion directly downstream of such modifications. In other words, this type of intervention takes what is already a bad situation and makes it worse. The practice of gravel and cobble removal also extends to islands that develop in the stream (Fig. 15)

Figure 15: A gravel island that is scheduled for removal in the near future. The rapid rate of its formation (and the rate at which it changes) is indicated by the general lack of vegetation that has been able to colonise since the previous removal of deposited material at this location. The island is shown on the Ordnance Survey map at this point (NGR SH 77145 48059) – indicating that it is a regular feature and that removal is unlikely to be successful.

Coniferous forestry drainage arrangements (along with any moorland drainage ditches that may exist) are the worst possible starting conditions for a river that is susceptible to sediment over-supply. Instead of acting as a sponge that absorbs and then slowly releases rainfall at the top of the catchment – water is conveyed immediately downstream from the point that it hits the ground. The result is highly variable, flashy flows that generate much more erosion of river bed and bank material. On top of this, the heavily grazed and hard (compacted by livestock footfall) land surrounding the river when it leaves the high moorland exacerbates the already flashy nature of the headwater catchment running off the high moorland and coniferous forestry slopes (Fig. 16). Because hard compacted ground with close-cropped vegetation is very poor at absorbing rainfall – surface water will immediately run off into the river. Moreover, the lack of complex vegetation (and associated below-ground root structure) renders the banks incredibly susceptible to erosion. The combination of highly erosive, flashy flows and highly erodible banks is a major source of over-supply of gravel and cobble substrate. The situation is further worsened by attempts to dredge the river and hold the channel in place with rock revetments. Both measures that increase erosion directly downstream of such interventions. What is more, the development of an over-wide channel due to grazing up to the river's edge could also be a major cause of gravel deposition in such wide reaches. Overall, the wildly variable flow, runaway erosion and resultant frequent and extensive redistribution of gravel and cobble do not appear to allow a productive food web to become established. Coniferous forestry and extensive grazing right up to the river bank limit the amount of leaf litter (and terrestrial invertebrates) entering the stream. Erosive flows largely prevent the retention of what little leaf material enters the stream as well as creating a hostile, frequently disturbed environment for periphyton, macrophytes, aquatic invertebrates and other fauna.

The range of sensitivities represented by the low numbers of aquatic invertebrate taxa that were found to be present indicate that water quality is likely to be sufficiently good to allow a range of sensitive species (including trout) to exist. A low abundance of individual invertebrates could be an indication of the generally nutrient-poor environment.

Figure 16: High moorland (left of frame) and coniferous forestry (centre/right of frame) headwaters running past a loose, exposed scree slope.

Recommendations

Although the specific cause/causes of the apparent dramatic decline in trout numbers within the Afon Machno may not be limited to the pressures identified during the site visit, it is clear that trout populations will suffer whilst these pressures are allowed to exist. The known key processes to focus on are:

- Reduction of frequency and intensity of spate flows and sediment supply
- Increase in hydrological roughness of river margins to “brake” in-channel spate flows (coupled with consolidation of bank matrix via extensive root system development)
- Increase of supply of primary productivity via leaf litter deposition (and retention) in stream
- Increase of supply of secondary productivity via terrestrial prey items input into stream
- Increase in provision of pool habitat via
  - natural narrowing of the channel resulting from re-vegetation
  - increased presence of stable woody debris

Specific measures

Creating vegetated buffer strips on both banks of the river via livestock exclusion and supportive planting of trees/understory where necessary will result in:

- Increased infiltration of rainfall that will help to reduce the erosive power of spates by intercepting surface runoff
- Braking of flows within the channel adjacent to banks by more extensive foliage (increased hydrological roughness)
- *Reduced cobble/gravel supply via stabilization of banks by root structures*
- *Reduced need to remove substrate/construct hard revetments to attempt to control rate of loss/change of farmed field areas (both important financial considerations for landowners)*
- *Reduced accumulation of gravel in over-wide sections that landowners currently expend time and resources removing*
- Increased deciduous leaf litter supply with attendant increase in the standing crop of invertebrates within aquatic food webs (and consequently greater provision of prey for large predators, including trout)
- Increased retention within the stream of such supplied leaf material due to attenuation of flood flows
- Increased supply of natural timber into the river channel (to help retain leaf litter inputs and promote scour pool habitat formation)
- Increased supply of terrestrial invertebrates to predators in the stream (including trout) during periods when aquatic invertebrates are not active/available to predators
- Increased opportunity for adult stages of aquatic invertebrates to complete their lifecycle adjacent to the stream and return for egg laying (varied stories of vegetation heights provide the best opportunities for this)

Identifying the points at which water leaves and re-enters the river channel during “out of bank” flow events will allow:

- The identification of areas where fencing will run parallel to out of bank flows (and hence be largely unaffected – even when constructed using standard materials and designs)

- Strategic location of special fencing panels at points where flood waters leave and re-enter the main channel (e.g. top-hung panels used in classic “water gates” used for livestock crossing points) that withstand flood flows and are easy to maintain. Such panels can also be included at points that field boundary fences that are perpendicular to the river are adjacent to the river.

N.B. an alternative to this option is to use standard panels that are designed to deliberately break away during spate flows (requiring only a small number of known panels to be replaced/maintained on a regular basis)

Consulting the existing forestry plans for the creation of hardwood corridors adjacent to watercourses within softwood plantations (e.g. along the Afon Glas Gwym tributary) and identifying opportunities to improve drainage arrangements for both forestry and moorland management that will reduce the flashy/erosive flow regime (i.e. grip blocking) will:

- Reduce the amount of cobble supply and erosion rate (again saving costs for landowners trying to manage both processes from within the river as well as promoting retention of nutrients/development of aquatic foodweb)
- Increase the efficacy of downstream measures to control erosion/create good habitat

What if trout populations do not recover?

In the absence of trout population recovery following the implementation of the suggested changes to land-use practices (assuming significant increases in aquatic invertebrate abundance as well as good habitat for all trout life-stages – including sufficiently stable spawning substrate have been achieved), it may be appropriate to consider direct population restoration measures. *However, such measures are entirely pointless without first tackling the land-use and habitat issues identified in this report*.

In the specific circumstance that the habitat and land-use concerns are tackled and there is no indication of improved trout recruitment in 3 to 5 years following habitat restoration – then it may be appropriate to consider additional investigations/solutions. *However, the WTT strongly suggests that wild brood stock or similar supportive breeding programmes are* ***not attempted in any circumstances*** *on the Afon Machno*. Opting for wild brood-stock/supportive breeding programmes not only deplete the donor populations of breeding stock, but have also been shown to produce first generation offspring that are significantly genetically different from progenitor wild stocks. Such inadvertent selection of traits favoured in domestication results in poorer performance in the wild than that of stream-bred fish. The very limited set of circumstances that supportive breeding schemes might achieve more good than harm categorically do not apply in this case. There is no lack of potential spawning, juvenile or adult habitat – and it is concentrating on converting “potential” to “actual” that successful outcomes can be won. The WTT would also be interested to view available trout survey data for the waterbody that could be used to inform any potential recovery trajectory.

Making it happen

Since all of the measures suggested in this report rely on implementation and maintenance of modified land-use, the failure or the restoration of the waterbody hinges upon landowner involvement. For this reason it is important to use the funding sources that are specifically available for Water Framework Directive-led works as an incentive for landowner buy-in. For example, employing liason officers and producing supporting interpretive materials can make the financial arguments to landowners apparent – as well as providing funds to support the necessary changes. In addition to this, taking legal advice on the degree to which landowner responsibilities to remove causes of waterbody failure criteria can be enforced is likely to become crucial. In this way, a combination of funding/technical support for achieving positive measures and penalizing the continuation of damaging practices under European law is likely to be more successful than either approach in isolation.