Advisory Visit

River Vartry, Co. Wicklow, Ireland

24th & 25th February 2016

1.0 Introduction

This report is the output of a site visit to the River Vartry, Co Wicklow, Ireland, at the request of Luke Drea from Vartry Anglers Conservation Club (VACC). The purpose of the visit was to assess riverine habitats and make recommendations for improvements that could be undertaken on the River.

Normal convention is applied throughout this report with respect to bank identification, i.e. the banks are designated left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience.

2.0 Catchment Overview

The River Vartry rises to the eastern side of the Wicklow Mountains National Park within bedrock geology of predominately greyslack (a hard dark sandstone), dark blue-grey slate, phyllite & schist. The superficial, surface geology comprises mainly till (derived from sandstone and shale) with glaciofluvial sands and gravels becoming more prominent in the mid-lower catchment. This geology is likely to produce a neutral to slightly acidic pH and, correspondingly, a medium-low productivity watercourse. This is borne-out by the predominantly migratory trout (*Salmo trutta*) population as is common where slower growth rates make the migration to richer marine feeding grounds a beneficial life strategy. Analysis of fish stocks on the Vartry by Inland Fisheries Ireland (IFI) and formerly the Central Fisheries Board confirms slow growth rates. That said, it is suspected that some trout do remain resident within the river as catches of what appear to be resident brown trout (identified by higher condition factor and colouring) are occasionally caught (L Drea, 2016, pers. comm., 25 February).

Another factor that could be significantly impacting upon resident trout is a history of periodic pollution incidents, the causes of some of which have been identified but others remain unclear. Fortunately, kick-sampling surveys a short time after the most recently recorded event identified minimal impact upon invertebrate life.

With regard to fish stocks, pollution incidents obviously have greatest potential impact upon resident trout populations where all life stages are exposed, unlike migratory populations where at least a portion of the spawning stock will be at sea. It is to be hoped, however, that the upper reaches of the River and any tributaries will not have been impacted by the pollutions and should naturally provide fish to the River.

This is a prime example of one of the many ways in which small tributaries are so important to the health of fish stocks on a river and should not be overlooked. It is also possible that, with lower fish stock densities within the

River, some offspring of the migratory trout may remain resident to take advantage of the opportunity.

Aside from resident and migratory trout, the River Vartry also supports a population of Atlantic salmon (*Salmo salar*) which actually show as the most abundant species in juvenile salmonid surveys, as undertaken by the IFI. This is despite their near absence in angler catches; a suspicion being that the salmon run is very late in the season after angling has ceased for the closed season, although this is unconfirmed. Eels (*Anguilla anguilla*) and lamprey (*Lampetra* spp.) are also recorded in electrofishing catches.

The flow regime on the Vartry is significantly impacted by abstraction from drinking water reservoirs within the upper catchment which impose unnaturally low summer flows upon the River, particularly in dry years (L Drea, 2016, pers. comm., 25 February). This is another factor that could increase the suitability of the river to migratory stocks over that of the resident fish by providing high flows and good spawning habitat in the winter but greatly diminished habitat availability (space) in the summer months, thereby increasing density (a key trigger for juvenile dispersal/migration). The reservoirs also degrade a large area of habitat on the River and pose a migration barrier; however, a large natural waterfall in the middle reaches of the river prevents migratory fish access that far upstream. The presence of a series of man-made and natural barriers on the middle-lower system also inhibits fish movement through those areas. Low river flows is another potential contributing factor to a late salmon run; salmon being less likely to ascend obstacles in low water, particularly when compared to than sea trout.

3.0 Habitat Assessment

VACC-controlled fishing starts at the outflow to Vartry Reservoir, the lower of two reservoirs on the river system, and from this point down a combination of spot-check and river walk assessments were undertaken. For reference, the assessment within this report is therefore covered in specific sections.

3.1 Reservoir Dam to Devil's Glen

The reservoir dam poses an impassable barrier to upstream fish passage and the dam itself is likely to significantly reduce the downstream dispersal of fish from the upper catchment (Fig. 1), although it is probable that occasional fish do make it downstream over the dam, particularly in high flows. This does, however, mean that the section between the reservoir and the natural impassable waterfall in Devil's Glen is poorly connected to the rest of the river; a significant issue when faced with a catastrophic fish kill within that reach, as occurred in June 2012.

Figure 1. The Vartry Dam poses an impassable barrier to fish migration and effectively encloses the VACC waters at the u/s limit.

The River channel d/s of the dam is wide, with emergent vegetation taking up a large portion of its capacity in either margin. This further suggests low summer flows that are facilitating the channel narrowing with vegetation (Fig. 2). Owing to the water-feed to this channel being an overspill, water within it may be severely depleted at low summer levels. However, the reach d/s of here, towards the waterworks, could have provided a fish refuge during the pollution incident that was identified as originating in the vicinity - providing that the channel had sufficient water supply at the time. Concerns were expressed about low summer flows, particularly in the upper river as few additional tributaries join this section of the river to mitigate the reservoir abstraction (L Drea, 2016, pers. comm., 25 February). Within the channel, habitat appeared capable of supporting trout but is distinctly lacking in structure and natural river habitat diversity, so is far below optimal quality.

Figure 2. Immediately d/s of Vartry Reservoir – emergent vegetation encroaching into the channel suggests a significant discrepancy between the flows observed and low summer conditions.

Further d/s, habitat quality improves markedly through a reasonably low gradient river valley, although the planform of the River suggests historic channel realignment (straightening). This theory is supported by the course of the river largely hugging the extremities of the floodplain (the likely location to which it would be moved, to provide the largest uninterrupted grazing areas), a relatively straight channel (in many areas), elongate pool and riffle sections and the presence of obvious dredging spoil on the banks that appear to have been deployed to reduce inundation of the adjacent fields (Fig. 3). Nonetheless, the habitat requirements of a resident trout population are relatively well catered for in the section inspected.

An un-grazed buffer protects the banks and channel from livestock access in many areas, allowing the development of a natural, roughly vegetated river margin and stable banks (Figs. 3 & 4); this also helps to limit inputs of fine sediment through reduced erosion and by intercepting any surface runoff. Where present, bankside trees provide valuable shade and cover, although a few additional trees would further improve habitat quality. River substrate is adequately sorted to provide habitat for healthy invertebrate communities and salmonid spawning, aided by little obvious bank erosion and fine sediment input.

Figure 3. Where present, riverside fencing provides a valuable buffer from the adjacent agricultural land and has facilitated the development of a healthy, roughly vegetated river bank.

Although inaccessible to migratory fish from d/s and being subject to the major fish-kill (2012), this area represents an opportunity to greatly diversify the scope of VACC, enhancing the fishing resource to include wild brown trout fishing. The habitat in the area is certainly suitable for supporting a healthy trout population, providing sufficient wild stock remained to repopulate it following the pollution incident. A few speculative fishing outings should soon identify whether any fish remain (electrofishing surveys would also be beneficial) and, providing there are fish remaining, it is recommended that they are preserved and allowed to naturally fully repopulate the area where they could then be utilised as a wild catch and release fishery.

Figure 4. Looking u/s from Annagolan Bridge. The river supports some high quality habitats with marginal cover, stable banks and a gravel and cobble substrate; however, the channel does appear unnaturally straight in many areas.

3.2 Devil's Glen

The valley alters markedly d/s of the wide, low gradient section, forming Devil's Glen, a steep gradient, high-sided bedrock and bolder gorge (Fig. 5). Owing to the constrained nature and gradient, the finer gravel substrate is naturally washed through many areas, only being retained in discrete pockets where reduced gradient and in-channel structure dissipates the flow energy (Fig. 6). The generally coarse nature of the substrate here is therefore a natural occurrence, owing to the physics of the area, and not something to be unduly concerned about. Areas capable of supporting spawning are present in lower energy areas at the tails of larger pools etc. and the rest is excellent juvenile habitat.

There is no lack of gravel and cobble substrate within the system and trying to input gravel within the gorge is likely to be unsustainable long-term as it would simply wash out. In addition, d/s of the gorge, where the gradient reduces and valley widens, gravel is again retained naturally. Spawning fish will take advantage of these areas where they naturally occur and if they are d/s of juvenile habitat, juveniles often disperse u/s to take advantage of it. This highlights another important reason for maintaining fish passage in a natural free state and for removing obstructions wherever possible.

Figure 5. Looking u/s within Devil's Glen. High quality juvenile salmonid habitat and a few niches for resident trout. Juvenile salmonids may disperse u/s to such sections from spawning areas d/s, as well as more obvious d/s dispersals from gravel pockets further u/s.

Figure 6. Discrete pockets of finer cobbles and gravel suitable for salmonid spawning are deposited in some areas, often towards the tail of larger pools and around structure like trees and boulders.

The steep nature of the valley through Devil's Glen naturally limits the amount of direct sunlight that can reach the valley bottom and is likely to lower temperatures and limit primary productivity in this area. While this is likely to slow the growth rates of fish, such areas are also beneficial in maintaining water temperature within the tolerance of salmonids (prolonged exposure to temperatures >18-19^{o}C causes chronic stress), particularly in light of increasing temperatures globally and low water levels. Steep valley sides also render most of the tributaries in this area inaccessible to fish and therefore unusable as spawning or nursery areas (Fig. 7), again highlighting the importance of maintaining natural, free passage of fish (u/s and d/s) within the rest of the river system to allow optimal habitat utilisation.

Figure 7. Most tributaries entering the Devil's Glen section are too steep to be utilised by fish.

As well as providing dissipation of flow energy, the few deeper pool areas within the gorge also provide important resting/refuge areas for larger migratory salmonids and possibly the occasional adult resident trout (Fig. 8). Fish will accumulate around these areas in the lead up to spawning time, taking advantage of the deeper water refuge and often cooler temperatures, before dispersing out onto the suitable gravel and cobble areas to spawn. Maintaining structure/cover within these areas of channel is therefore important to provide security and protection from predators.

Figure 8. Deeper pool areas within the gorge will provide valuable refuge for larger fish. Overhanging and trailing trees/vegetation offers them valuable cover and security.

3.3 Nun's Cross Bridge to Ashford

The valley starts to widen out again d/s of Devil's Glen and the river gradient decreases, increasing the occurrence of gravel and cobble deposition (Fig. 9). This provides more potential spawning habitat, diversifies habitat for juvenile salmonids and invertebrates. Only a spot check was undertaken at Nunn's Cross Bridge (Fig. 9) but further inspection of this area was undertaken from Ashford, working u/s and into the d/s of the woodland where valuable lower gradient wooded river habitat is present.

Approximately 300m u/s of the weir, on the RB, was the first sighting of Japanese knotweed (*Falopia japonica*), although further inspection to verify that this is the u/s limit would be beneficial. Its location lies directly alongside the large area of made-up ground and it may well be that this is its source on the river, resulting from soil imported from outside the catchment. Long-term treatment of knotweed relies upon identifying its u/s limit and working in a d/s direction from there to prevent re-infestation.

Figure 9. Looking u/s from Nunn's Cross Bridge. The lower gradient (compared to Devil's Glen u/s) here and d/s through the woodland naturally facilitates retention of a wider range of substrate sizes.

Directly u/s of the recently collapsed Ashford Weir (Fig. 10) is a newly improved and developing section of river (Fig. 11). Far from the weir collapse being a negative thing, removal of such a large obstruction from the river channel is a massive improvement to the habitat quality locally and to the overall quality and connectivity of habitats along the river.

The once impounded section now supports high quality riffle and glide habitat with a healthy abundance of low-level branches and trailing/submerged root cover (Fig. 12). This area was previously an easy hunting ground for predators and poachers, undoubtedly increasing losses of juvenile fish (including smolts) on their d/s migration, acting as an ideal spot where fish-eating birds could easily corral fish.

The area is still adapting to the increased energy and substrate transport post-impoundment but requires minimal, if any, work as the habitat is already very high quality. The weir collapse is undoubtedly the best thing that could have happened to improve habitat quality, fish passage and sediment transport in this area. Weir removal is always the optimal solution, wherever possible, with fish passes and easements a poor second best for fish passage and habitat improvement. The breach of the weir will have also reduced potential flood risk it posed to surrounding property and infrastructure, especially in light of made ground on the RB that potentially disconnects high flows from the floodplain.

Figure 10. The remains of Ashford Weir. Collapse of the central section of this weir has facilitated the significant habitat improvements u/s, reinstated sediment transport through the area and greatly improved habitat connectivity/fish passage.

Figure 11. The once-impounded river section now provides a diverse range of high quality habitat. Laurel provides some good cover but it would be better removed to allow natural species colonisation.

Figure 12. High quality deep glide habitat with readily available overhanging/in-channel cover. Note the greatly reduced water depth owing to the loss of the impoundment d/s. This has re-energised flows and returned the section to the high quality habitat it should naturally provide.

It may be suggested by some that the presence of additional weirs d/s in Mount Usher Gardens negates many of the benefits of Ashford Weir collapsing and that it would be better to reinstate it; however, this is far from correct. Each impoundment creates its own negative impact both upon habitat quality, sediment transport and fish passage and these impacts are cumulative – the greater the number of structures, the greater the negative impact upon the river and its ecology.

Even when "most" fish can pass a barrier, there is still likely to be a considerable problem for the overall fish population. There are usually several barriers (natural and manmade) on a river system – not just one. This means that a group of fish trying to migrate will keep losing members of that group at each barrier, through stress, predation, and exhaustion, missing the passable flow/river height or simply failing to find a passable point on the weir/barrier.

For example, if you imagine six barriers that are each passable by 75% of the fish attempting to ascend them, it sounds like they would only pose a small issue for the overall population. However, this would mean that out of a group of 50 fish below the first barrier, only 10 would make it to the spawning grounds above the sixth barrier. In reality, that's a big reduction in the total number of potential mating pairs and offspring that could be produced.

Restricting a population into unnaturally small spawning groups/areas can lead to chance having a much greater impact in the genetics of a river's fish stock, rather than normal natural selection that tends to favour beneficial traits. The figures used are just for example, but provide a realistic overview as there are a range of factors that will affect the passability of each structure to each individual fish (fish size, fitness, where it naturally chooses to attempt to pass, flow etc.). Simply seeing 'some' fish get over a structure gives no real idea of the number of fish that 'should' be passing it, with the smaller fish (including precocious mature parr) that often struggle the most comprising an important component of the overall spawning stock. It is therefore vital to ensure that manmade obstructions are removed wherever possible and where they absolutely cannot be removed, they are made as passable as possible.

There is definitely potential also to improve the passability of weirs through Mt. Usher Gdns by removing (some), lowering, notching or creating easements over them (Figs. 13 & 14). The feasibility of those options would have to be ascertained through discussion with the owners. It is unfortunate that the river has been so restricted and impounded by manmade and adapted natural obstructions in this area as they undoubtedly detract from the habitat quality and natural function of the river. As with so many habitat impacts, such work was undertaken before the importance of free fish movement and sediment transport on rivers was appreciated. While providing interesting features and reflections, the impounded sections u/s of the weirs actually provide a far less diverse and dynamic spectacle than the natural pools and riffles that would exist there and this is definitely something to champion when entering any discussions regarding improvements.

The natural barriers and bedrock outcrops need not be altered as they are invariably more passable than un-natural manmade obstacles or ones that have been altered with stone/concrete. It is the impact of manmade alterations and additional un-natural barriers increasing the number and scale of obstacles that causes major issues for fish populations.

Deeper pools around the natural bedrock section provide valuable resting areas for migratory fish stuck below the structures due to flow or temperature barriers. It is not fully understood whether any salmon make it this far during the fishing season, where they are simply inaccessible to anglers. It may be that they are simply very late running (after the fishing season) as they rarely show in angler catches despite high numbers caught in juvenile surveys d/s (L Drea, 2016, pers. comm., 25 February).

Figure 13. The largest weir in Mt. Usher Gardens. This is a sizeable obstruction and likely to inhibit fish passage, particularly at low flows and for the vital smaller/juvenile fish that are often overlooked.

Figure 14. Series of weirs/adapted natural bedrock structures. The closely mown river margins on the LB (right of shot) also greatly reduces habitat quality within the pools and the cover available to fish trapped within them.

3.4 Tributary channels through Ashford/Mt. Usher Gardens.

A small tributary enters the River Vartry via a number of channels through Ashford and Mt Usher Gdns. This may originally have provided notable potential as a spawning tributary; however, significant channel alteration has affected its accessibility and flow-regime. Natural bedrock obstacles towards the d/s end of one of the lower outlets *may* have also naturally inhibited fish passage.

At the children's play area (farthest u/s location inspected on the tributary) two large, near impassable manmade weirs effectively prevent further u/s passage although habitat above the weirs offers further potential spawning and juvenile habitat if access were restored, as does the watercourse d/s though the park (Figs. 15 & 16).

Figure 15. The farthest u/s location inspected on the tributary, showing the first of two co-located, impassable weirs. Habitat d/s is suitable for spawning and juvenile salmonids.

Figure 16. Habitat within the park is of a reasonable quality for spawning and juvenile salmonids, if a little exposed and lacking low cover.

A short distance d/s, a leat that once supplied water from Ashford Weir into the tributary remains connected but now seemingly takes a portion of the flow from the tributary and discharges to the River Vartry at the u/s side of the Ashford Weir (Fig. 17). Although this reduces flow within the tributary d/s of this point, it may ultimately make the tributary more accessible for fish from the main river (via the leat), particularly to the park and children's play area. Flow and substrate in the visible section of the leat suggests that it too could provide potential spawning and juvenile habitat and may be worth enhancing. However, further inspection is required to confirm there are no additional barriers to fish movement within the leat.

Further d/s on the tributary, several structures are used to regulate flows and are likely to pose barriers to fish passage u/s through the channels within Mt. Usher Gdns and probably d/s. The barriers include sluices (Figs. 18 & 19), weirs (Figs. 20 & 21) and culverts/piped channel sections. The impact of these structures should ideally be assessed from the least passable and farthest d/s of the structures as these effectively form the limiting factor.


Figure 17. Leat connecting the tributary with the u/s side of the remains of Ashford Weir.

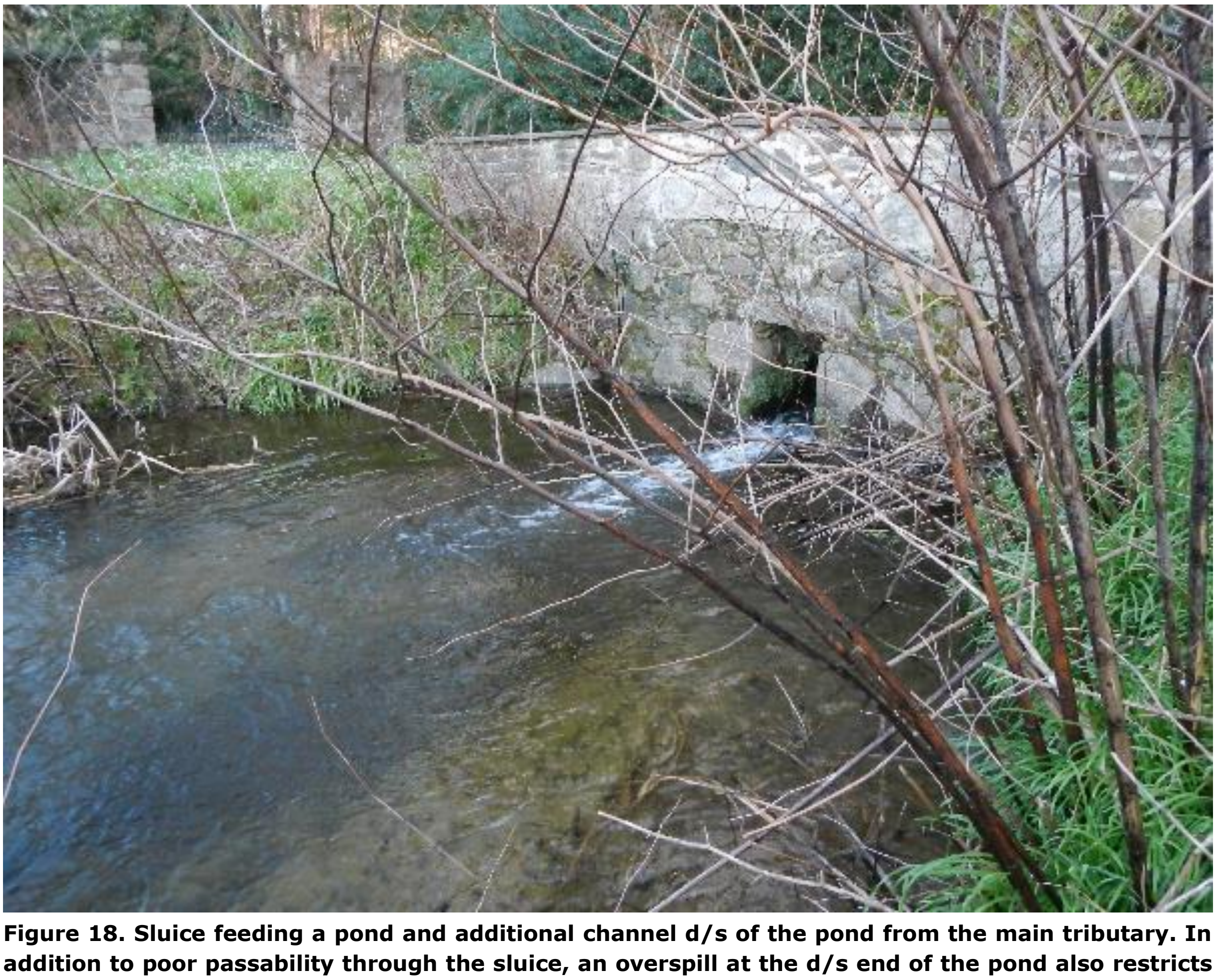
Figure 18. Sluice feeding a pond and additional channel d/s of the pond from the main tributary. In addition to poor passability through the sluice, an overspill at the d/s end of the pond also restricts u/s migration via this route. Also note the Japanese knotweed (brown canes - right of shot).


Figure 19. Sluice that further splits flow from the main flow of the tributary and supplies the small channel re-joining the main channel d/s of the falls in section depicted in Figure 21.


Figure 20. Small weirs that degrade habitat but are of minimal impact owing to the barrier d/s (Fig. 21).

Figure 21. Semi-natural barrier that is likely to prevent u/s access on the main stem of the tributary.

The large semi-natural waterfall (Fig. 21) and another large structure on the adjacent smaller side-channel render the two farthest d/s channels largely inaccessible (barring the lower 100m of low value habitat) and the overspill at the d/s end of the pond and sluice on the other channel u/s (Fig. 18) also preclude migration through those routes. This leaves only a short distance of channel d/s of the pond (Fig. 18) accessible from the main river and although the habitat is of limited quality (Fig. 22), there were some signs of attempted spawning activity there, likely because fish that are unable to reach adequate spawning areas had to make do (Fig. 23). It might be worth enhancing this lower channel for spawning with the inclusion of gravels as, on a small, low-energy tributary/artificial channel, they are more likely to be retained.

Figure 22. Relatively poor quality habitat in the accessible but artificial channel section in the Gardens, d/s of the pond depicted in Fig. 18.

Figure 23. Despite the poor quality of the channel d/s of the pond some signs of spawning activity were observed on the bed.

3.5 Downstream of Ashford

Through the farmland d/s of Ashford, the gradient of the channel reduces further and a more natural channel than is present through Ashford provides a diversity of depths and flows with a greater availability of deeper natural pools (Fig. 24). Spawning and juvenile habitat remain available through this section but there is a notable increase in the availability of adult trout and migratory fish holding water. This section is also where the occasional larger resident brown trout have been caught (L Drea, 2016, pers. comm., 25 February).

Valuable low-level and trailing cover is readily available along many areas of the banks, with habitat being particularly good where livestock are excluded.

Figure 24. In the lower gradient section of the River with a greater availability of deeper pool habitat.

Progressing d/s, knotweed becomes more prevalent and poses an increasing issue, causing over-shading of valuable native grasses and herbaceous vegetation, only to die back in the winter leaving the banks exposed to severe erosion. There definitely appeared to be some reduction in the strength of knotweed stands within grazed fields, but even grazing was not sufficient to keep the knotweed growth under control (Fig. 25). This associated loss of bank material resulting from knotweed growth is a major issue from fine sediment input, over-widening of the channel and a loss of habitat.

Figure 25. Japanese knotweed within a lightly grazed field. The grazing is not preventing its spread and the knotweed stand is leading to significant bank loss that it likely to further threaten the stability bank and neighbouring trees if left untreated.

Management of riverbanks and adjacent fields is always complicated as livestock grazing alone leads to bank instability (Fig. 26). This is because the extent of root structures, and therefore consolidation of the soil, is related to the vegetation and foliage visible above the ground. Grasses are the only species capable of withstanding prolonged grazing pressure and alone, they do not provide very deep or diverse root systems, particularly when most of their growth is replacing foliage grazed above the ground, rather than extending their roots. Compare the very shallow root structure within the bank in Figure 26 with the extensive root matrices provided by a range of species within a fenced, well-vegetated buffer strip (Fig. 27); the erosion there occurred after a tree collapsed but the bank quickly recovered through the stability provided by other root systems.

Whether the scene in Figure 26 is due to grazing pressure alone or knotweed too (which has been washed out) is unknown but management of the field is greatly complicated by the knotweed as simply fencing the stock out could allow it to proliferate. The only sustainable plan for managing habitat on the river will involve eradication or, at least, serious control of the knotweed throughout, to allow the installation of buffer fencing. Without this, the banks will continue to destabilise and bankside trees and vegetation will be lost, with significant detrimental effects upon the populations of fish and other wildlife that utilise the river corridor.

Figure 26. Significant bank erosion. Note the lack of root structure within the soil to bind it together and compare with Figure 27, within a well-vegetated buffer strip. In contrast, the tree-lined RB is stable and provides good quality cover and fish holding habitat.

Figure 27. With livestock excluded, grasses and other vegetation establish extensive foliage and root systems which offer far greater bank stability than grazed banks (Fig. 26); also allowing banks to naturally regrade following erosion. Management of non-native invasive species remains an issue.

Directly d/s of the erosion, potentially high quality spawning habitat for salmon and sea trout was observed (Fig. 28). However, the quality of this habitat and the survival of any eggs that are laid within the gravels will be seriously compromised by the u/s erosion and inputs of soil/fine sediment. Fine sediment deposited over gravels blocks the spaces between them, not only reducing the habitat niches available for beneficial invertebrate species but also inhibiting the through-flow of water within the gravels that is vital to oxygenate incubating fish eggs.

Even under the tree shade, the unfenced near bank supports a far greater diversity of plant life and is more stable than the grazed, far bank (Fig. 28). Correspondingly, the far bank is subject to erosion that has exposed the tree roots. The lack of vegetation also reduces vital cover and the availability of sanctuary areas in the river margins that would otherwise greatly enhance salmonid fry and parr habitat. Grazing also prevents natural tree regeneration to create an understory of shrub and smaller, lower trees as saplings are eaten off with the other vegetation before they can become established. This also limits the availability of low-level and trailing cover that would enhance the area for adult salmonids.

Figure 28. Potentially high quality spawning habitat that could be greatly improved by excluding livestock from the riverbank to increase vegetation cover.

Where livestock access is reduced, low-level and trailing cover greatly enhance habitat quality (Fig. 29). The remains of a suspected small weir is also present but in its dilapidated state it poses no real issues.

Figure 28. Improved cover availability greatly enhances this area. The remains of a small boulder weir (right of shot) poses no real impact.

A question was raised as to whether the depth of the pool in Figure 29 could be increased to improve its fish-holding potential. This is a complicated issue as simply deepening a pool will not work long-term. If a pool is artificially deepened, widened or impounded, the loss of flow energy within it will ultimately lead to it filling in with bed material from upstream. The only real sustainable solution is to address the reason that the pool might be becoming shallower in the first place.

Flow entering the pool has a certain amount of energy and put simply, it has the potential to do several things; transport material through, leaving the pool largely unaltered; erode the bed; erode the banks; or deposit material on the bed. A combination of these factors will occur over time, depending upon the flows received but one of those factors is likely to be the overriding one. With stable banks, a pool will find equilibrium, with flows transporting substrate through and making very little alteration. However, in this instance, the LB is well protected by root structure but the grazed RB is far less stable, so although it is on the inside of a bend, it is easier for high flows to erode laterally into that bank than transport the material supplied from u/s through the pool. This causes the pool to retain material, becoming wider and shallower over time.

Fencing the RB to allow it to become more stable and withstand higher flows means that flow energy would maintain sediment transport through the pool, by scouring the more easily moveable bed material rather than eroding the banks, re-deepening and maintaining the pool depth. The pool may even narrow slightly as deposition on the inside bend becomes consolidated. Aside from erosion of the RB, the pool does provide high quality habitat with a valuable well-shaded margin along the LB but with adequate light penetration. It is vital to maintain this low tree cover wherever possible as the enhancement to fish holding that it provides is what creates the fish-holding potential.

The first sighting of what is believed to be skunk cabbage (*Lysichiton americanus* - other skunk cabbage plants confirmed d/s) was also made here along the RB. This is another non-native invasive species that can out-compete natives and is likely contributing to the bank stability issues.

Figure 29. A pool providing good quality habitat; however, a lack of stability within the RB will ultimately lead to widening and shallowing over time as the reduced flow energy leads to deposition of bed material within the pool.

Two large d/s facing groyne structures that have now become dislodged have exacerbated erosion of both banks around and d/s of their original location. This is because, while they funnel flow into the centre of the channel at low flows, higher flows passing over them are diverted outwards, towards the bank. Similarly, u/s facing groynes tend to deflect water away from the bank as they are overtopped (see Fig. 31). Groynes are only usually of value on heavily altered or degraded channels as on more natural river channels (like most of the Vartry), it is far better to work with natural structures and process. Removing the old groyne structures from the channel would be beneficial to reduce the potential for further detrimental erosion and naturalise the channel.

Figure 30. Collapsed d/s paired deflector that would have focussed flows to the centre of the channel at low water but deflected any high flows that overtopped the structure into the banks, causing erosion and widening the channel.

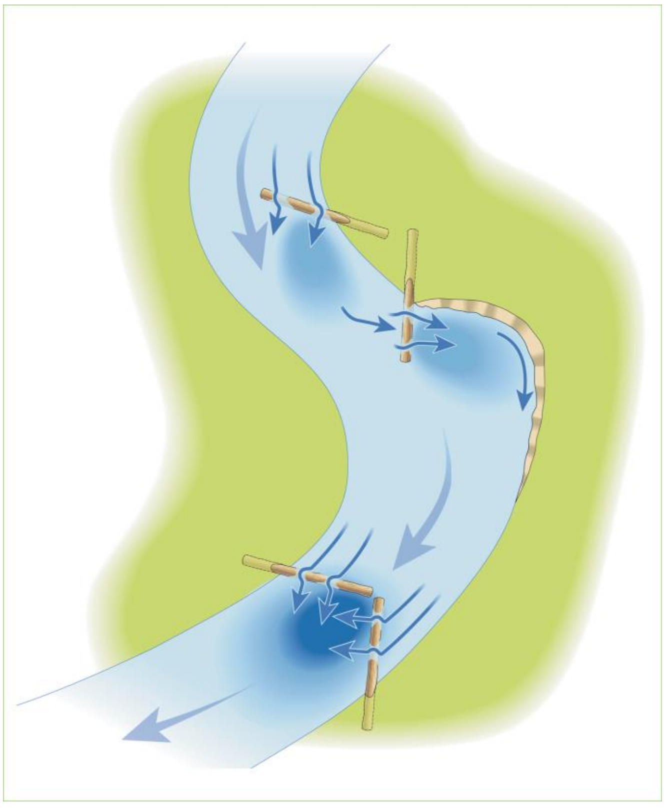

Figure 31. Several flow deflector orientations. Note how the d/s facing deflector sends flows towards the bank when overtopped.

A bankside willow (*Salix* sp.) d/s of the groynes could be beneficially laid along the bank (as you would lay shrubs within a hedge) to improve the availability of low cover and improve its ability to hold fish (Fig. 32). The convention is to lay willows at 45° or less angle facing d/s, so as not to trap debris and to reduce the flow pressure acting upon them. However, in this instance, owing to the tree's location and orientation of its branches, the technique can only be employed by laying the branch u/s along the bank where it could be secured to a fence (or live willow) post with hessian rope, towards the tip end.

Figure 32. The right hand trunk of the willow tree (centre of shot) could be laid along the bank to provide low-level and trailing cover to the pool.

Erosion on the inside of the large bend u/s of the M11 road bridge (Fig. 33) is seriously threatening bankside trees, with some already having become out-flanked by the river (Fig. 34). In all likelihood, these trees will be lost in high flows if the ground cannot be re-consolidated.

As is often the case, the bend has been used for feeding cattle; it seems an obvious location from the perspective of it being well draining ground, usually comprising coarse river bed material. However, encouraging heavy grazing and poaching activity near to a watercourse will always lead to bank instability. Creating a focal point for livestock by a watercourse also increases the volume of sediment and faecal matter there, leading to siltation and excessive nutrient input. Buffer fencing the river and locating feeding points well away from the river is the ideal solution here.

Figure 33. Locating a feeder directly adjacent to the river is leading to excessive bank erosion and sediment and faecal matter entering the watercourse.

Figure 34. Focussing grazing pressure and poaching along the river bank also further destabilises the bank and makes bankside trees more prone to wash-out. Note how one tree has already been out-flanked by the river.

In locations throughout the river, small bankside shrubs present an opportunity to increase low cover through laying, particularly along the non-fishing banks (Fig. 35). As described previously, this technique works well with willows, which may even take root from any branches touching the ground or water, but can be applied to other pliable species such as hazel (*Corylus avellana*), elm (*Ulmus minor*) and hawthorn (*Crataegus monogyna*). Any tree work, should be done sparingly so as not to create one type of habitat at the expense of another.

Figure 35. Occasional bankside shrubs could be laid to create additional low cover, as depicted by the red outline.

Knotweed is an increasing issue, the stands becoming larger d/s. Under the M11 road bridge the knotweed appears to have been cut (Fig. 36). It is hard to imagine this being done once it is dead which suggests that it would have been done while the plants are still alive. This kind of treatment is highly inappropriate and likely to constitute an offence in spreading the weed as knotweed plants can become established from even tiny propagules (bits of stem/branches), meaning that cutting a large stand like this has the potential to widely spread and exacerbate the issue. As the cutting has only been undertaken beneath the bridge it is suspected that the cutting was done by individuals tasked with maintenance of that structure. The only appropriate treatment of knotweed in this scenario is by licensed personnel with herbicide that is approved for use by a watercourse. Further areas of skunk cabbage were also noted on the LB at the first large bend d/s of the M11. This should also be treated in the same way (Fig. 37).

Figure 36. A large area of Japanese knotweed that has been cut, potentially distributing the problem much farther afield.

Figure 37. Skunk cabbage to the right (spears emerging along the waterline) and behind a bankside tree (large green and yellowish-green leaves.

At a fording point, a combination of physical damage and backwash from cattle and vehicles crossing, coupled with cattle poaching and grazing has destabilised the bank and led to major erosion that now threatens both the ford and a peninsula of land d/s, as the river tries to cut through at high flows (Fig. 38). Rock armouring here is not a suitable solution because the hard structure would simply deflect scour leading to further erosion around the rocks and erosion u/s and d/s of them.

The ideal solution is to fence cattle out of that whole corner of the field, whenever not in use for fording, and to increase the roughness of the area with pinned brash, particularly at the far side where high flows are returning to the river after cutting the corner (Fig. 39). This will slow the transition of flows cutting across the area and, coupled with the loss of energy when the flow enters the large erosion void, will dissipate the flow energy, reducing erosion and creating a depositional area. This will simply and effectively make the main river channel the path of least resistance for high flows and keep it where it should be. The key will be to ensure that there is sufficient roughness over the ground (effectively small brash logjams) and to keep livestock off the area. Without grazing pressure, the area should revegetate and stabilise but it will be important to maintain permanent stock exclusion when the area is not in use for fording.

Figure 38. River flowing L-R with erosion at both sides of a fording point. Recent flood flows have exacerbated erosion on the already destabilised far bank and started to cut across the bend.

Figure 39. Slowing the transition of water across the bend and restricting its egress at the far side would greatly reduce the flow energy across the bend, reducing erosion and causing any bed material to be deposited there, turning it from an area of scour to an area of deposition. This would also encourage flows to follow the original channel course as the path of least resistance.

A small side channel around an island provides some valuable habitat diversity (Fig. 40). The reduced flows within the channel has facilitated deposition of finer gravel substrate than is available in the main channel. This area offers habitat for aquatic invertebrates and also, potentially, spawning substrate and habitat for smaller salmonids. The notable sediment inputs upstream will inevitably degrade the quality of this habitat which is yet another reason to increase bank stability and reduce bank erosion.

Figure 40. Valuable habitat diversity provided by a small side-channel.

3.6 Downstream of Newrath Bridge

Newrath Bridge demarks the current d/s limit of VACC sole occupancy of the river, with other anglers having access from that point and d/s. The section immediately d/s (Fig. 41) is the location that the IFI surveys are undertaken and that generates high numbers of salmon parr (higher for salmon than trout). While the habitat there is of reasonable quality for juvenile salmonids, it is not completely representative of the whole river, particularly when considering the inaccessible low gradient upper section (u/s of the impassable falls), the steep gorge, and the notably impounded Ashford section.

Figure 41. Newrath Bridge – the d/s limit of VACC sole occupancy for angling and the location of fisheries surveys.

The issues with knotweed continue to increase through the lower fields, to the estuary/Broad Lough, with an associated negative impact upon habitat. Much of the bank is seriously de-stabilised and eroding (Fig. 42) and large areas of the river bank are shaded-out, with the knotweed outcompeting almost all other species (Fig. 43). Loss of land on the inside of bends (Fig. 44) may also be linked to the knotweed issue along that bank section as, without negative impacts upon them, the inside areas of bends would usually remain relatively stable. Although the major bank erosion/land loss are limited to certain areas currently, the sheer extent of knotweed infestation and rate at which the species can colonise further means that the erosion issues will only get worse, potentially much worse if measures to control it are not taken. This is equally true for sections u/s.

Figure 42. The knotweed issue progressively increases d/s, with large stands on both banks and associated bank destabilisation issues.

Figure 43. A near monoculture of knotweed exists along the river bank in many areas.

Figure 44. Erosion on the inside of a bend, an issue that only generally occurs where something has first reduced the stability of the bank.

In areas where the knotweed is not yet so extensive, some high quality habitat exists, suitable for both resident trout and as holding water for migratory salmonids (Fig. 45). The overhanging trees and trailing branches provide vital cover, but also sanctuary and protection for fish from high flows and predators such as 'poachers' and piscivorous birds like cormorants. Fish can negotiate their way through in-channel structures such as branches and logs far more easily than the birds can.

The larger woody material also provides important structure within the channel that focuses flows to enhance scouring of the river bed (Fig. 46). This develops and then maintains pools and sorts gravels by size – the finer material being carried further than the coarse material which drops out of the water column more quickly to form valuable spawning areas and invertebrate habitat.

Figure 45. Trailing branches provide vital cover and shelter for all stages of the salmonid lifecycle. However, flows constricted by the willow will place pressure on the near bank which is destabilised by the knotweed, leading to erosion. This would not be an issue on a naturally vegetated bank.

Figure 46. Large woody material within the channel is again vital for cover, scouring the bed and developing pools and maintaining the bed free from fine sediment.

As with most other sections of the river, there is no major issue with gravel supply and distribution but particularly in the section d/s of Newrath Bridge, the river is particularly active in gravel transport. This forms numerous gravel bars and riffles that are valuable salmonid spawning and invertebrate habitat (Fig. 47). However, they are likely to remain more mobile than would naturally occur due to knotweed preventing their colonisation and stabilisation by native vegetation.

Figure 47. There is ample gravel supply throughout the river but its transport is particularly active in the lower reaches.

Approximately half way between Newrath Bridge and the Broad Lough, tree and vegetation 'maintenance' by unknown personnel begins to have a significant negative impact upon habitat quality, with the low and trailing branches that provide such high quality habitat in other reaches being cut off to allow easy access to the river (Figs. 48 & 49). This greatly reduces the habitat potential of this area of river. It was also noted that signs were vandalised and hundreds of euros worth of damage has been done to the buffer fencing, with the two top strands of barbed wire having been cut to ease access at all likely fishing spots along the lower reaches of the river.

Figure 48. Pruning the lower branches from the ash tree beside this pool has greatly decreased the pools habitat quality and fish holding ability. Access is easier but there will be fewer fish there.

Figure 49. Unsympathetic cutting of valuable in-channel cover habitat.

Figure 50. In addition to inappropriate tree/vegetation pruning, signs have been vandalised suggesting possible contention between users of the area.

In the very lower reaches of the river, some treatment of the knotweed has been undertaken. This work is to be highly commended and although it has not completely eradicating the plant, the knotweed is being reduced (Figs 51 & 52). When treating knotweed, it is vital not to use a herbicide with a long lasting residual effect as this will prevent the recolonisation of native vegetation that is required to protect the bank and result in equal issues. It is also important to start at the u/s limit of the infestation and this will require a coordinated catchment-scale initiative. While the work on the lower river remains very valid, it will be an ongoing battle to maintain it free of knotweed that is recolonising from sources u/s.

Figure 51. Post treatment of knotweed, some native vegetation is beginning to recolonise.

Figure 52. Post treatment of knotweed and some areas of bank remain bare. It would be beneficial to reseed here with a locally native grass and/or wildflower mix to protect the bank. Note the dense stand of knotweed still present on the untreated far bank.

At its d/s extent, the River Vartry discharges into Broad Lough, an extensive tidal lough that offers a further diversification of habitat on the Vartry system and provides a buffer between riverine and marine habitats (Fig. 53). It is highly probable that migrating fish utilise this area to ease the difficult physiological transition between those habitats both on their u/s and d/s. Furthermore, it potentially provides additional habitat for juvenile salmonids, particularly sea trout parr/smolts, which often inhabit such rich feeding areas.

Figure 53. Broad Lough provides a buffer between riverine and marine environments and potentially provides additional juvenile salmonid habitat.

4.0 Recommendations

4.1 Non-native invasive species

Undoubtedly, one of the greatest threats to the River Vartry is the widespread infestation of knotweed which will continue to expand across the catchment. It is already causing significant issues with over-shading of native species, leading to bank instability in many areas, and will continue to spread if left un-checked.

The only realistic solution is a coordinated, catchment-scale initiative incorporating all riparian owners/tenants. Work already undertaken in the lower reaches of the river has already greatly reduced the weed in many areas and this approach should be initiated right along the river, starting at the most upstream knotweed location, suspected to be c. 300 metres u/s of Ashford Weir, on the RB.

The skunk cabbage noted in the area d/s of Rosanna House (around Figure 29), at the bend depicted in Figure 37, and anywhere else it is identified should also be treated. It too is likely to cause further issues by out-competing beneficial native species, if allowed to proliferate.

4.2 Bank erosion

If the knotweed issue can be controlled, it is recommended that a buffer fence be installed along all grazed river bank sections to exclude livestock. This will then allow the development of more extensive vegetation that will provide improvements to both habitat and bank stability.

Various techniques can also be employed to tackle areas of eroding banks with natural materials such as brash, as shown in the accompanying WTT bank protection document. It should be noted, however, that bank protection is unlikely to be sustainable long-term without addressing the non-native plant species issues that are causing the issues, in most cases. This is also true for the area in which the River is cutting across the bend at a fording point (Fig. 38), although roughening the bank with brash would start to address the issue of erosion as described previously and potentially reduce the issue.

4.3 Barriers to fish movement

The disintegration of the large weir in Ashford is undoubtedly a major improvement to habitat quality and connectivity, greatly improving fish passage and sediment transport through the site. As the weir is now largely obsolete anyway, it is strongly recommended that any plans to reinstate the weir are prevented, citing the significant detriment to the river of doing so. Some work to improve the aesthetics of the structure may be beneficial but it should be ensured that no alterations to the continuity of natural river bed be made.

Several other barriers to fish movement are also present on the river. These potentially fragment fish populations along the watercourse and pose additional stresses to wild fish stocks. Without the ability to move freely u/s and d/s in a river, fish are deprived of the ability to move between the various habitat types required to fulfil their lifecycle and to achieve optimal utilisation of habitats through natural dispersal. It is appreciated that the weirs may provide aesthetic amenity value to other users of the area but it is recommended that discussion is entered into with the owners to ascertain if any of those structures could be removed and whether easements or passes could be installed on any that absolutely cannot.

It would also be worth looking into the possibility of removing the weirs at the u/s side of the children's play area and whether this would open up much potential spawning habitat (10-60mm diameter silt-free gravel/cobble) further u/s.

4.3.1 Water flows

Flows on the River were at a healthy level during the visit, as would be expected during winter/spring, so it is difficult to assess the extent or impact of low flows on the river. However, it is worth investigating with the operators of Vartry Dam to ascertain whether any increase can be made to the compensation flow, if any, which is released from the Dam. Furthermore, studies such as that undertaken by Dave Archer and Godfrey Williams on the river Tyne (http://hydrologie.org/redbooks/a231/iahs_231_0003.pdf) and the proceedings of the Atlantic Salmon Trust workshop in 2010 (www.atlanticsalmontrust.org/library/library11.pdf) suggest that initiating a more natural, variable flow regime, with freshets to simulate natural flow variations can greatly improve the habitat quality and ecology of a river, as well as improving fish passage.

4.4 Tree work

In general, the lack of tree pruning and channel maintenance that has been undertaken on VACC waters is to be highly commended. This has allowed the establishment of a diverse array of, natural bankside and in-channel structure that is undoubtedly benefiting the River's fish stocks. The only addition that would be beneficial to make is the occasional laying of suitable species along or into the channel and possibly some light planting in open areas. Planting is likely to also require livestock exclusion from those areas as they are almost invariably going to be causing the lack of natural tree regeneration.

The process of laying a tree or branch is simple, it involves cutting part way through the stem/trunk, a little at a time (like laying a hawthorn hedge), until it can be forced over into the channel (Figs. 54 & 55). The depth of the cut should be limited to only that which is required to bend the limb over, as this will retain maximum strength in the hinge and maintain the health of the tree/shrub. On smaller shrubs, simply cutting the stem/trunk at a very shallow angle and then putting an axe blade into the cut and hitting it with a hammer can also help the laying while retaining a good strong hinge.

This is a great method to rapidly increase low cover but should be employed sparingly so as not to detract from other valuable tree habitats. The method is best employed specifically where the additional cover is likely to directly benefit fish holding capacity of an area.


Figure 54. Hinged willow.


Figure 55. Hinged hazel.

4.5 Gravel introduction

Although gravel introduction is not usually recommended on a natural river channel as a natural channel will only retain substrate appropriate to its physical parameters and what is supplied from upstream, where significant human alteration has altered the channel or interrupted the supply of gravel, introduction may be beneficial.

This is the case on the d/s end of the various tributary channels through Mt Usher Gdns, where barriers prevent fish migration u/s to more natural sections and limit gravel supply. Simply installing discrete beds of 10-40mm and 20-50mm diameter gravels would provide valuable spawning areas for migratory trout and smaller sea trout, and for salmon, respectively. Ordinarily, it would usually be easiest to just install a full range of gravel sizes; however, owing to the limited space and un-natural flow regimes of the channels, separate beds of the designated sizes would probably work best, with the larger gravels being located in areas of higher flow velocities for the salmon and the smaller gravels in slightly slower areas for the trout.

As is unfortunately the case with artificial spawning beds that are not the result of natural sediment supply, they are likely to require cleaning/raking and maintaining/replenishing on a regular basis to keep them functioning and free from fine sediment. Ensuring that the material is placed in areas with the maximum peak flow velocities that will still allow them to be retained will limit the extent of maintenance required and most closely mimic natural spawning areas.

4.6 Further investigation

One tributary of the Vartry that joins on the RB towards the d/s end of the wood, u/s of Ashford, was not inspected and further investigation of the size and accessibility of fish to that tributary is recommended. The same is true for the tributary which joins a short distance d/s on the LB, within the section previously impounded by Ashford Weir.

Sea trout will often utilise the smaller tributaries as spawning areas, away from the higher velocity flows of the main river. These areas can also offer valuable juvenile habitat so their protection and maintenance in a natural state can be important.

4.6.1 Pollution

The significance of historic pollution incidents on the River cannot be overstated. Such events have a potential to greatly impact upon both resident and migratory fish stocks. It is therefore vital to report such incidents to the appropriate authorities as soon as they are identified and to follow up on issues with them until positive action is taken. It is understood that the VACC already operate in this manner wherever possible yet, unfortunately, at least one of the recent major pollution events went largely unidentified. This is not reason to give up; it is important to keep pushing for action and answers in these situations.

It is understood that the impact of the 2012 incident had a catastrophic effect upon the fish stocks but a much more limited impact upon the invertebrates. It is common for invertebrate populations to recolonise and re-establish rapidly via natural 'drift' from upstream following a pollution event but the minimal impact noted within surveys commissioned by VACC only weeks after the incident suggests that the pollutant was something to which invertebrates are largely impervious.

Chlorine and chloramines (derivatives of ammonia mixed with chlorine) at high concentrations (or low concentrations but via longer-term exposure) can kill fish but leave invertebrates relatively unscathed. Affected fish typically express symptoms at the gills; they often show signs of excess mucus and may appear bright red or even be bleached (white) if subject to a severe exposure. This is despite observing no notable invertebrate kill. Submerged macrophytes or benthic algae d/s may also show signs of bleaching.

It is understood that a potable water treatment works is located on the river in the area where the fish kill took place and it is possible that the works uses chlorines and chloramines. However, another avenue of investigation into the incident may be to check what other compounds are used in the water purification process there. Many toxicants can exceed the lethal threshold for fish but leave invertebrates relatively unscathed, particularly when observations are only made using routine family level invertebrate sampling.

Aluminium sulphate is often used as a flocculent in potable water treatment and is also potentially extremely damaging to both the environment and public health if wrongly used (www.bbc.co.uk/news/uk-england-cornwall-24164253). Aluminium can be very toxic to fish when the pH of the water is low (acidic); it is a contributor to fish kills caused by acid rain, which washes aluminium salts from the soil. By contrast, some groups of aquatic invertebrates which score highly in pollution indices (hence indicating good water quality) can be remarkably tolerant to heavy metal pollution; this can make the usual invertebrate scoring systems ineffective in detecting heavy metal pollution incidents, although the Ephemeroptera, Plecoptera, Trichoptera Index (EPT Index – calculated by summing the number of taxa represented by these three insect orders) can sometimes be employed to detect metal or organic pollutants.

Without a chemical signature or species level invertebrate fingerprint, it is only really possible to hazard a guess at what happened. However, it is strongly advisable that VACC maintain a stock of unused 1 litre PET bottles handy in which samples can be taken in case it this happens again. These can then be sent away to an analytical lab for chlorine and chloramines analysis. NB: samples may require freezing for storage and during transport for analyses; check with potential analysts.

It is also possible to purchase hand-held kits for testing chlorine which will detect concentrations sufficiently high to cause a fish kill. Similarly, but probably as effective for high concentrations, the human nose can usually detect whether chlorine is present. Simply take a sample in a bottle, lid it with a ~10% air space, shake vigorously, and smell immediately after lid removal. If chlorine is detected, it should be immediately be reported to the IFI and any other relevant authorities, including the water company, as they should wish to address the issue rapidly to avoid prosecution.

5.0 Making it Happen

WTT may be able to offer further assistance such as:

- WTT Project Proposal
    - Further to this report, the WTT can devise a more detailed project proposal report. This would usually detail the next steps to take and highlight specific areas for work, and provide a more detailed explanation of the how it can be undertaken, with the report forming part of any required consent applications.
- WTT Fundraising advice
    - Help and advice on how to raise funds for habitat improvement work can be found on the WTT website - www.wildtrout.org/content/project-funding

In addition, 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

We have 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.

6.0 Disclaimer

This report is produced for guidance; 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.

7.0 References

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