BARRIERS TO FISH MIGRATION
IN
UPPER RIVER ALMOND, LOTHIAN REGION

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1. BACKGROUND

One of the key points in a recent report based on an advisory visit made by the Wild Trout Trust (WTT) to stretches of the River Almond, Lothians, on behalf of Cramond Angling Club (Walker, 2007), was that the Club should seek and collaborate with other parties interested in the welfare of the river and its fish stocks. The Club needs to foster a wider interest in the catchment than simply the lower parts of the river where it holds fishing leases for salmon and trout. Good progress has been made since then, including a preliminary assessment of a series of weirs and barriers to migration situated in the upper river and its main tributaries. I carried out a second advisory visit on 12 March 2008, this time independently from WTT. The aims of the visit were to consider improvements to fish passage arrangements in the middle/upper catchment, leading to prioritisation of plans for possible action. Detailed engineering proposals might have to be drawn up later by specialists and submitted to the competent authorities.

Salmon and trout, as migratory species which ascend rivers for varying distances in order to spawn, depend upon good access to upper areas with well-oxygenated and cool water, with suitable depth for cover and suitable flows, maintaining clean gravel of a size composition suitable for spawning. Optimum conditions for spawning vary with fish species and body size, but in general salmon prefer stronger flows and larger gravel size and are more likely to spawn in main river channels than trout, which spawn more frequently in feeder burns ranging from 1-5 metres wide. Unlike salmon which at this latitude are obligatory migrants to the sea, juvenile trout may spend their entire lives within small burns, or drop downstream, although staying within fresh water, or migrate out into coastal seas, where the feeding is better but the trade-off is that there are many predators. Sea trout and brown trout spawn together and are genetically indistinguishable, based on present evidence. However, sea trout are treated as salmon in fishery legislation. In practice, although they are considered separately in law, brown trout living in rivers like the Almond require the same consideration with regard to upstream and downstream migratory access. Almond brown trout will drop downriver to varying distances in the course of their development and, through their innate homing tendencies, like salmon and sea trout, they will try to return to their natal areas in order to spawn. Clearly, the extent to which each of the migrating fish are blocked by weirs and other obstructions can be critical to their effective dispersal and ultimate survival as thriving populations. Also, barriers are major sources of concern for poaching and other fishery management problems.

Background information about the river was provided by a report on water quality in 2006 from the Scottish Environmental Protection Agency (www.sepa.org.uk) and, earlier, from an honours thesis "An assessment of the River Almond as a salmon river" by Ian Reid (1985), The Univ. of Edinburgh. The following information is copied from the first advisory report (2007). "According to SEPA, the Almond, which is about 50 km in length, is being brought back from being perhaps the most polluted river of its size in Scotland. The presence within the catchment of the central Scottish coalfield and the Lothian oil shale field meant that mining operations affected water quality in the past. By the end of the 18th century there were also numerous mills and associated weirs, among them Cockle Mill, Fairafar, Peggy's Mill, Dowies Mill and Craigie Mill, forming barriers to fish migration. Even in the first half of the 20th century the river was practically unable to support salmonid fish. The Scottish Advisory Committee on River Pollution (1935) reported that the Almond at Cramond was nearly black at times. Gradually, however, through the instigations of the Forth River Purification Board and now SEPA, and the decline in heavy industry and coal mining, the water quality has improved substantially. Efforts have been made to address fish passage at weirs and the river now supports significant runs of naturally-maintained salmon and sea trout. Brown trout are widespread and a few grayling, believed to be recently introduced, are present in upper/middle parts of the catchment and may well spread throughout the river in time.

.Substantial increases have taken place in urban developments and these continue to expand, with consequent concerns for maintaining high quality sewage treatment and disposal. SEPA reports that the Almond river water quality is heavily influenced by the increasing and varied land use in the catchment. However, the incidence of untreated sewage discharges during heavy rainfall events has increased as the capacities of treatment works are stretched to their limits. There is also substantial surface water discharge from the widespread impermeable surfaces created by human developments and problems of disposal of de-icing agents from Edinburgh Airport during winter and storm overflows, bringing in varied pollutants that continue to remain a problem for water quality. Wide modern roads and motorway systems in the area tend to have long culverts which may be obstructive to fish migration. The Gogar Burn is heavily engineered and culverted. In 2004, SEPA classified 77% of the Almond as "Fair" in water quality and the remainder as "Poor". The How and the Breich Waters and the Caw and Ryal Burns, combining with the Brox Burn, remained polluted and contributed towards lower water quality in the main river. Some parameters, for example, nutrient levels, showed large improvements from 1996 – 2004, however, there were also deteriorations. Iron concentrations in seven stretches went from good status in 1999/2000 to fair status in 2004. On the other hand, the Linhouse and Murieston Water continued to have good quality status and provided a flush of clean water into the river below Livingstone, while supporting good fish populations." Although SEPA has not yet published an updated assessment of water quality, it is believed to be basically as described above. Ambient water quality is likely to vary with precipitation and river discharge levels.

Following the Industrial Revolution, the River Almond became grossly polluted and fish passes were redundant because the water quality was inadequate to support healthy salmon and trout populations. However, substantial improvements in water quality have been made in recent decades and salmon and trout have returned. Notwithstanding the difficulties described earlier, further progress in cleaning up the river can expected under Scottish environmental legislation arising from the EU Water Framework arrangements. There should be potential to enhance current levels of stocks of salmon and trout, freshwater eels and other fish species and related wildlife in the river and its immediate corridor as the clean-up takes place. Much of the improvement in fish stocks ought to occur naturally as better environmental standards are achieved. However, it is essential to minimise any problems for fish passage at weirs and barriers in order to maximise the potential for upstream penetration and sustainable recolonisation. There may also be problems at lades, where migrating fish are diverted from the river. The current statutory background derives from the Salmon (Fish Passes and Screens) (Scotland) Regulations 1994, which apply to dams in and off-takes from inland waters which ordinarily contain upstream migrating salmon. The regulations state that the owner/operator of every dam shall ensure that it is provided with a fish pass which facilitates the free passage of salmon at all times except during periods when the flow of the river is so low that salmon would not reasonably be expected to seek passage. The regulations also cover the operation of lades and their screening to prevent ingress and loss of migrating smolts and adults. Notes for guidance on the provision of fish passes and screens for the safe passage of salmon (Anon 1995) related to the above regulations are available from the FRS Freshwater Laboratory, Faskally, Pitlochry, PH16 5LB.

2. ADVISORY VISIT

The advisory visit undertaken on 12 March was helped considerably by the excellent discussion document, "Upper Almond Improvement", prepared by Paul Buchanan, Pete Hill and Fen Howieson (22 Jan 2008). This well-illustrated report, intended for internal discussion between Cramond A.C. and other interested parties, highlights problems for migrating fish at a number of barriers and proposes improvement measures. It also recounts some angling observations about the upper river. Paul was on hand all day to show the river and its weirs, while Pete and Fen joined us later to discuss some preliminary thoughts and conclusions. The river was flowing at a moderate to high level after a relatively mild but wet month.

Plate I: Linhouse Water near its confluence with the River Almond by Mid Calder

We looked briefly at the lower sections of the Linhouse Water and the Murieston Water, or Bog Burn (Plates I&II) which, as already stated, have good water quality and probably contain much of the better spawning and nursery habitat for both salmon and trout in accessible parts of the upper catchment of the Almond. Paul commented that the Murieston Water is more significant than it might seem for it holds its flow level better than the Linhouse, although appearing to be much smaller on OS maps.

Plate II: Murieston Water (Bog Burn) which joins the Linhouse near its confluence with the River Almond

Mid Calder Weir is a significant barrier in the River Almond situated a few hundred metres below the mouth of the Linhouse Water. Indeed, Buchanan *et a*l (2008) state that this is the most formidable barrier in the catchment. Salmon and trout can ascend in spates, but it causes them significant delay and probably physical damage and is a great gathering place for poachers from September onwards during the back-end salmon run. Water falling over the sloping weir face, which is some 2 metres or more in vertical height, runs onto a wide concrete apron, providing little depth for running or jumping fish, unless the river is very high. A simple concrete box fish pass arrangement is set in the middle of the weir but, according to Buchanan *et al*, only about 5% of the fish are seen trying to enter this. However, it is possible that the pass works better at some water heights when fish may be able to pass through unseen. According to Reid (1985), the weir was impassable until 1978, when the fish pass was installed by the then Almond Angling Association (now defunct), with assistance from Lothian Regional Council. Sea trout used it immediately and salmon were expected to do likewise. Paul Buchanan commented that he sees sea trout jumping at the extreme left bank of the weir where it is less high (looking downstream). Near the right bank, erosion of the apron has provided extra depth and therefore more amenable conditions for salmon and they can be seen lying there as they make their way upstream. Unfortunately, these fish are in reach of poachers with landing nets and in need of greater protection. It is commonly observed that salmon and trout often jump at different parts of falls and other obstructions. Swimming and leaping potential are related to body size, but there may also be some species-specific requirements for fish ladder performance. Most fish passes in common use in the UK have been designed to be used by salmon.

Plate III: **Mid Calder Weir**

Plate IV: **Mid Calder Weir**

Plate V: **Box-type fish pass at Mid Calder Weir** (Plate III enlarged)

As there are doubts about the effectiveness of the fish pass, consideration should be given to opening or removing the weir, which appears to serve no purpose now. The loss of the pool upstream which is popular for trout fishing is one disadvantage. Also, the exposed bed would be raw and unsightly until naturally re-vegetated. If the weir is retained, a slot could be cut in the lip above the eroded portion of the apron, to create more flow at that point and provide further encouragement to upstream movement of fish near the right bank (looking downstream). Another possibility is to construct a fish pass in the channel of the now derelict lade (same side), although it would need to be fenced or covered as protection from poachers. Yet another is to modify the existing box pass to reduce the individual fall and straighten the flow by adding one or more boxes. The present arrangement appears to make the fish jump to enter and then turn at right-angles to reach the next level, in water that may be excessively turbulent (and see Plate XI). [Designs known to be effective include the Pool and Weir Pass, the Denil, the Alaskan Steeppass (modified Denil), the Vertical Slot Pass, the Uniform Gradient (simple ramped) Pass and the Diagonal Baulk Pass (see "Notes for Guidance on the Provision of Fish Passes and Screens…" (Anon,1995)). Shallow ramped passes are used in the Island of Funen, Denmark to overcome functioning or heritage site weirs where it is important not to lose the head of water. These roughened ramps, essentially mimicking a natural cobbled substrate in order to break up the flow, are cut through the weirs at an intermediate height to project out into the head pond, thus maintaining a shallow slope while keeping the entry point as close as possible to the foot of the weir.] Specialist engineering advice may have to be sought but the ultimate choice of ladder design could depend on overall costs. Anon (1995) provides estimated costs for construction of about £25k/m head for pool and weir passes and £15k/m for modular Denils (1994 prices). As the weir is already passable, there may be considerable savings in modifying the existing ladder or the points on the weir near the right bank where fish are known to get through successfully, such as the eroded section by the right bank. However, the fabric of the weir may be becoming undermined by erosion and further work could exacerbate the breakdown of the structure.

The next obstruction visited was the one below the sewage works downstream from Mid Calder. A long, curving, largely cobbled, structure, this one provides river water for the Union Canal via a sluice into an unscreened lade. It seems likely that a proportion of the descending salmon and sea trout smolts and brown trout find their way along the weir face and into the canal where they may be eaten by pike. Although the entrance is unscreened, there is a legal requirement for a smolt screen to be installed at its entrance (The Salmon (Fish Passes and Screens) (Scotland) Regulations 1994). Also, there should be a bypass overspill near the screen to divert back to the river any fish that are attracted along the face of the weir. There is a bypass of sorts, either intended or due to gradual breakdown of the weir wall, but it is too far away from the lade intake to be effective as a fish diversion. {Screen designs are shown in Notes for Guidance on the Provision of Fish Passes and Screens for the Safe Passage of Salmon (Anon 1995).}

The law also specifies that only sufficient water for the purpose intended should be taken by individual lades. Buchanan *et al* (2008) comment that the canal might be drawing too much water. There is a sluice to control the flow but no obvious signs of monitoring equipment. Concerns about abstraction levels should be addressed to SEPA to deal with under the new CAR regulations.

Much of the cobbled, shallow-sloping weir itself appears readily passable by ascending fish in high water conditions, although the lack of a deeper section in the face and the rather broad and shallow water immediately below the weir are unhelpful. Depth could be increased below the weir by removing some of the loose cobbles that have accumulated over time, even using these to back-up a pool beneath. It is assumed that the weir will be retained as a means of supplying water to the canal. Nevertheless, it ought to be possible to dish the face over a short section near the main flow at the right bank to help upstream migration. Increased velocities of water at this point may then scour out a better channel for fish to approach the weir.


Plates VI & VII: Views of the lower Mid Calder weir and lade


Plates VIII & IX: More Views of the lower Mid Calder weir and lade

The weir near Livingston Rugby Club has a similar, but smaller, box fish pass to the one on Mid Calder Weir. Most of the steeply inclined weir face and platformed base are likely to present serious problems for ascending fish, however trout can ascend near the right bank. Paul said that the fishing pool above is excellent for brown and sea trout and felt that the weir should be retained for this reason, although he was uncertain whether salmon made it past here in numbers. As at Mid Calder, the right-angled box sections of the ladder create turbulence which may hamper fish movement. Paul's observations here were that the bulk of the fish tried to ascend outside rather than through the ladder. It would be difficult visually to assess whether movements through the boxes take place at some river levels without an electronic fish counter or video camera. There is scope to improve fish passage at this weir, as at Mid Calder, although its removal would be more certain to assist salmon.

Plate X: Weir at Livingston Rugby Club

Plate XI: Weir at Livingston Rugby Club

Another shallow, cobbled weir upstream has a very long, curved span so that the lip is very shallow over most of this length. According to Paul, in the early 1980s, Livingston Newtown Angling Club (also now defunct) tried to remove some cobbles at the top of the weir, but had limited success. However, we found that a section has recently broken through near the left bank and the more concentrated flow in that area has scoured out a deeper channel, making it easier for fish to ascend. This simple rubble weir seems to be breaking down and is not the awkward barrier that it used to be.

Plate XII: Curved, cobble weir also near the Rugby Club

Further upriver, we inspected a small weir below Almond Valley Bridge where there was no indication of any consideration for migratory fish passage. However, Paul said that fish appear to pass it without difficulty when the river is high, at which times it is almost inundated by the flow. Even so, it ought to have a dished section to assist passage at lesser flows. The most suitable point for this would be at the right bank (not shown), where the flow is already broken by some boulders, although this work would be of a low priority if fish are able to pass relatively easily. However, they then encounter a shallow pool and a difficult run up to the next weir.

Plate XIII: Weir below Almond Valley Bridge

The next weir, not far upstream and below an older bridge, comprised a long curved structure with a substantial overall slope and thinly dispersed water coming down it. The full width of the weir is not shown below (Plates XIV&XV)

Plate XIV: Weir below Almondvale Flats (a)

Plate XV: Weir below Almondvale Flat (left bank)

Salmon and perhaps also trout are likely to have difficulty passing this structure, because of the shallow approach and curved crest. Paul said that as far as he knew there have been no reports of salmon caught above this point, although one of the largest tributaries of the Almond, the Breich Burn, is only a few miles upstream. (However, the Breich Burn still suffers from water quality problems due to former mining).The best approach to the weir for migrating fish would seem to be near the left bank (looking downstream) and ideally a slot should be created there by removing some of the crest of the weir close to the bridge. Flow enhancement here should scour a deeper channel immediately downstream and the scouring process could be encouraged if necessary by removing some of the bed during dry weather. Work on the crest of the weir should be done with care in case of damage to the integrity of the foundations of the bridge. However, this modification should be fairly simple to accomplish and should help the fish get past, even though there is a worse barrier not much further up.

The next weir upstream (Plates XVI&XVII) diverts water via a lade to Mill Farm, which has a pond and a working water wheel. Again, no salmon have been reported above this weir which lacks a fish ladder and appears impassable. The vertical height is about two metres and the water discharges into a relatively shallow pool with concrete and rubble base, offering little opportunity for migrating fish to leap to any significant height. A ledge about halfway down the otherwise vertical face of the weir causes a secondary spray that would be another complicating factor for leaping fish. The Breich Burn, a potentially important spawning tributary, is only about a mile upstream. The lade has a sluice to control the flow but is unscreened. If migratory fish were allowed to get upstream past this weir there could be a need for a screen at the lade entrance and bypass for kelts and smolts etc. It may be argued that the water flowing through the lade eventually falls back into the river, so any fish moving downstream in its flow would do likewise. On the other hand, harm could be caused to the fish by the pond or more likely the water wheel arrangements which were not inspected during the advisory visit. However, Buchanan *et al* (2008) suggest in any case that salmon and trout do not reach Mill Farm Weir at present based on lack of evidence of fish jumping there on days when they can be seen jumping at weirs further downriver. If improvements can be made for fish passage at these lower weirs there will eventually be a need for a fish ladder at Mill Farm Weir. At the same time, the pool beneath it will need to be deepened. However, it would be advisable to carry out a biological and barrier survey of the Breich Water and other areas of the Almond upstream of this weir to assess their suitability and further accessibility for spawning and then for fry and parr production before installing a fish pass at Mill Farm Weir.


Plates XVI & XVII: Mill Farm Weir and Lade

In rapidly declining daylight we carried out a brief visit to the large natural rock shelf, a site of a former weir, at Clifton Hall. Then we looked at barriers on the Linhouse Water by Linhouse and Mortonhill.

Plate XVIII: Natural Shelf at Morton Hall with concreted lip

The complex broken rock shelf at Morton Hall is passed by both salmon and trout and has a number of fissures and other potential routes for upstream-migrant fish to proceed at a range of flows. The concreted top lip, intended to raise the height slightly to help divert flow through a lade on the left bank, is now redundant and could be removed in places, or completely, although it may not affect fish passage at times of reasonable river flow.

Plate XIX: Derelict weir on the Linhouse Water (upstream of a significant natural barrier)

As the Linhouse Water is one of the cleanest of the Almond tributaries, it is particularly important to identify any artificial barriers to fish movements there. There is a derelict weir (Plate XIX) at Linhouse that could be removed, however a natural waterfall downstream by Mortonhill (Plate XX) bars appears to block migrating fish, therefore work to remove the weir may be unnecessary. It may be possible to ease these falls by blasting, but the counter argument is that the areas of stream upstream of the falls will contain established isolated brown trout stocks and other fauna

that could be genetically modified or lost if additional migratory fish are given access. Similarly, stocking of salmon or sea trout could be carried out above the falls but the use of above-falls areas for stocking in order to enhance stocks of migratory fish is seen increasingly as bad practice from a conservation viewpoint.

Plate XX: Natural waterfall on Linhouse Water

3. CONCLUSIONS

There is a need to prepare a prioritised action plan for dealing with barriers in the whole Almond catchment that takes account of upstream ecological conditions as well as feasibility and costings for modifications to be made to improve accessibility for upstream migrating fish, mainly salmon and trout, but including eels and perhaps lampreys. A biological study, obtaining fish species presence and age/density information, would be very valuable in order to determine the present extent of salmon penetration and the potential for further improvement (juvenile sea trout cannot be distinguished from brown trout). The biological survey would be carried out first to identify shortfalls in stock abundance and set down a baseline of fishery data against which to measure any improvements that take place after further attempts are made to ease or remove individual weirs. Prioritisation of work on the barriers could then be based on a points system involving the estimated numbers of juvenile fish and then adults that would be gained if they were eased. This approach would give less importance to areas that are still badly affected by pollution, although recognising that improvements in water quality can be expected over time.

The fact that the barriers in the lower and middle reaches of the river are passed by salmon and trout already adds complexity, although they may still be causing temporary or partial blockages and failing to allow full penetration upstream. The core target must be to allow the fish to migrate upriver as quickly as river conditions allow, without artificial impediment. A biological survey at least of the Linhouse and Murieston Waters would ascertain whether these clean tributaries in the middle reaches contain salmon and are fully stocked with salmon and trout according to habitat availability. If they are not, this information will endorse work to be carried out on the sequence of barriers downriver. Given improvements in water quality upstream and also in some of the lower tributaries that remain affected by pollutants, work may have to be done to identify and hopefully then to ease further barriers in these areas, such as culverts under new roads.

With regard to the weirs looked at during the recent advisory visit, some are redundant now and should be removed, unless they have some role in flood defences, or they protect bridges or other infrastructure. Otherwise, work to ease fish passage at them could involve moving a few stones and perhaps cutting slots, or dishing parts of rubble dams. However, be mindful of implications of liability should there be any consequent river erosion. All work intended to ease or remove barriers must be carried out with due consultation with identifiable owners and the affected statutory authorities, especially SEPA. The Forth District Salmon Fisheries Board should be involved throughout in their role concerning salmon fisheries in the river. The redesign and installation of fish ladders at specific locations on the river requires specialist help. SEPA and FRS will be able to assist in finding suitable consultants in this field. These may include:-

Mike Beach Fish Pass Consultant (mike@beach.freeserve.co.uk)
Fishway Engineering (Tony@fishways.com).

It should not be overlooked that screening is required at the lade that supplies water from the river to the canal system and may be necessary at Mill Farm Weir, if migratory fish are permitted to pass this barrier. The owners of these and other lades are responsible for the installation and upkeep of such screens.

5. REFERENCES

Anon. (1995). The Salmon (Fish Passes and Screens)(Scotland) Regulations 1994. Notes for Guidance on the Provision of Fish Passes and Screens for the Safe Passage of Salmon. Available from FRS Freshwater Laboratory, Pitlochry, Perthshire PH16 5LB. 38pp.

Buchanan, P, Hill P.and Howieson, F. (2008). Upper Almond Improvement Discussion Document, Cramond Angling Association. (22 Jan, 2008)

Walker A F (2007). Advisory Visit to Cramond Angling Club on 26 August, 2007. Wild Trout Trust Report, 12 pp.