THE Tweed FOUNDATION

A Tweed Foundation Paper

Beavers and Fish

A: INTRODUCTION

Land and freshwater fishery managers have become increasingly concerned following the announcement of a licensed trial to introduce European Beavers to Knapdale in Argyll. Their concern arises around the widespread interpretation by those who campaign for Beaver introductions to Britain that this licence heralds the return of Beavers to the British countryside; alongside which there have been repeated and consistent claims that Beavers will only be good, especially for biodiversity, and that there will be no adverse effects. This is despite the acknowledged fact that Beavers make profound changes to the ecosystems in which they live by making dams in watercourses; indeed this is a much cited benefit.

The simplistic arguments that are presented to support the introduction of Beavers ignore widespread evidence that Beavers cause considerable damage both to the rivers and streams that they dam and also to the surrounding land. Much of this evidence is anecdotal but more is recorded in the scientific literature. Normally, when any major change to the English, Welsh or Scottish countryside is proposed, government agencies and others rightly demand appropriate assessments of the likely effects with particular reference to the literature, particularly where rivers or land under conservation designations such as SSSI (Site of Special Scientific Interest) or SAC (Special Area of Conservation) are involved. With Beaver introduction this process has been ignored; either no appropriate assessment has been made or none has been made public. This leaves a suspicion to many that the evidence may in fact be disadvantageous to the proposed introductions and that it is being suppressed. Land Managers are concerned that the changes to ecosystems that would be caused by the introduction of Beavers, which have been absent from Britain for many hundreds of years, would not be compatible with twenty-first century land use and is being proposed by those who have no responsibility for the country.

In December 2007 the Association of Salmon Fishery Boards formally asked the Scottish Wildlife Trust, to whom the Knapdale licence for the introduction has been granted, for a number of issues to be addressed so that an informed position could be arrived at before a trial was commenced. To date no response has been received. The unanswered questions that were drawn up are given in Appendix A.

Find out for yourself more about the work and costs that will be created by having Beavers in the wild in Scotland by using your internet search engine and doing web searches:

“Beaver fish passage”
“Beaver culverts”
“Beaver embankment” (Beavers can even derail trains !)

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THE TWEED FISH CONSERVANCY CENTRE, DRYGRANGE STEADING, MELROSE, ROXBURGHSHIRE TD6 9DJ
Tel: EARLSTON (01896) 848271 Fax: EARLSTON (01896) 848277
email: info@tweedfoundation.org.uk
Charity No. SC011055
A charitable trust established by the River Tweed Commission to promote the development of fish stocks in the Tweed River System

B: Beavers and Fisheries – Frequently Asked Questions

- *FAQs; questions with short answers in italics*
- More detailed answers, where available, with no italics.

1 Do Beavers eat fish?

No. Beavers are vegetarian. They can eat a wide variety of vegetation and are not restricted to tree bark.

2 Do Beavers cause problems for fish?

Yes. Beavers are interesting animals particularly because they have a great capacity to change habitat that does not suit them into habitat that does. This mainly involves changing shallow water into deeper pools by damming streams. These dams can then prevent or restrict spawning fish from getting further upstream in Autumn (see below).

3 Do European Beavers make dams or is it only Canadian Beavers that do this?

Yes, they do. So long as the rivers and streams in which they live are not too wide, European Beavers make dams when the water is not naturally deep enough to suit them.

It is sometimes claimed that European Beavers build fewer and smaller dams than Canadian Beavers but this contradicts the much advertised reason for their introduction to Scotland – that they will have major impacts on stream ecology, increase biodiversity etc. Beavers themselves can have no such impacts, it is only by building dams that they can. The position is therefore unclear.

4 Has the subject of Beavers and fish been well researched?

No. While it has been claimed that there is a "wealth" of research on this topic, this is specifically contradicted by statements in the scientific literature. There is indeed much research on Beavers themselves, however there is little on the topic of Beaver dams and their impact on migratory fish. Such research as there is shows that Beaver dams can cause significant problems for fish, particularly when autumnal rainfalls are low.

The lack of such research is specifically mentioned in the literature: Parker and Ronning (2007) make the point that "One potential area of conflict that to date has received little attention, particularly in Europe, is the effect of dam-building on the migration and reproduction of anadromous salmonids, in particular Salmon (Salmo salar) and Sea-trout (S. trutta)". Halley & Lamberg (2001) stated that "If the subject of the likely economic impact, if any, of Beaver damming on sports fisheries is to be addressed seriously, much more comprehensive investigation is required." There is however much information on obstacles and water levels in relation to fish movement, including work from Scotland, particularly in relation to the degree to which fish are able to populate upstream of obstacles. There are also a number of scientific papers and management guides on control of Beaver numbers to reduce impacts on forestry, roads and agriculture.

5 Beaver websites say that Beavers are beneficial for "fish"; is this true?

No, Beaver dams cause problems for migratory fish for the simple reason that the more obstacles there are in a stream for fish to get over, the more difficult migration up a stream becomes for them. Beaver dams are no different from man-made obstacles such as weirs, dams, fords, bridge foundations, etc. in this respect – and no-one thinks

that increasing the numbers of weirs and dams in a stream is a "good" thing for migratory fish.

It is also claimed that Beaver dams provide a richer environment and better growth for the fish living in them. However, such enrichment comes from the rotting of the vegetation submerged by a Beaver pond and is only a temporary feature of Beaver dams. Once all the vegetation has rotten away, any effect is lost.

For migratory fish, access is the priority. Even the poorest quality nursery area can produce at least some salmon and trout if spawning adults can get to it, but even the very best quality habitat cannot produce anything if spawners cannot reach it. Habitat "quantity" always has priority over habitat "quality".

A Beaver dam in Estonia. It is claimed that having such barriers across streams is "good" or "mildly beneficial" for migratory Salmon and Trout. However, no similar claim would ever be made for a man-made weir of similar size.

Scotlands's migratory trout and Salmon are by far and away the most economically important native fish. They breed throughout river systems including the smaller headwaters. The juveniles migrate downstream to the sea one to three years after hatching, returning as fully grown adults to migrate upstream to breed again. All Scotland's native fish, in fact, are migratory (or are resident forms derived from migratory fish) because Scotland never had a land-link (and therefore, fresh-water link) with continental Europe. As the ice retreated after the last Ice Age the only fish species that were able to colonise were those that could cross the sea. Anything that impedes this migration process affects the success of these species.

The pools created by Beaver dams may be good for larger trout and other predators

such as Pike (which is not native to Scotland). Beaver ponds will create habitat for these predators on Salmon and trout nursery streams which would otherwise be too shallow for them to live in. A series of Beaver ponds, each with large trout / Pike in them would be a series of "ambushes" that Salmon and juvenile trout migrating downstream would have to get through. If there was a large spate at the right time, the fish could get past quickly – without a spate, they would be very vulnerable.

The best account of the effect of such habitat changes on fish populations is given in a Swedish paper, Hagglund & Sjoberg, (1999). This showed that streams are changed by Beaver dams from being shallow waters dominated by small juvenile trout to deeper, slower, waters dominated by larger trout and non-salmonids. Overall, trout numbers in the stream sections with Beaver dams declined compared to sections without, due to this change-over from more numerous juvenile to less common adult trout. Minnows (*Phoxinus phoxinus*) did the opposite, increasing in the sections with Beaver dams. There have been a number of papers in recent years from Norway, where Minnows have been recently spreading to coastal river systems, which show they compete with trout juveniles and reduce their numbers and restrict their ranges. Spread of Minnows within trout spawning burns, such as is described in this Swedish paper as an effect of Beaver dams, is not therefore desirable.

In many river systems in Scotland, even large ones, it is becoming apparent that the resident Brown-trout fished for by anglers are largely produced by Sea-trout females whose egg production dominates small streams. Spawning Brown-trout females also migrate up smaller streams from the deeper water in the main channels where they live. In such situations, habitat for larger trout on small streams is of no advantage to the population, since it is more important that the migratory females get as far and as fast upstream as possible to cover as much spawning area as possible.

The natural situation is for juvenile trout produced in the smaller streams of river catchments to drop down into the main channels, stocking the areas fished by anglers. Any reduction in the amount of habitat for juvenile trout in these smaller burns must have an impact on trout fisheries downstream. The replacement of juvenile trout by Minnows in such small streams is not an advantage to fisheries.

For enhanced growth to be an actual advantage to a fish population (as opposed to individuals), a significant proportion would have be living in Beaver dams, which would (on a stream of any length) require a lot of dams that would cause access problems. negating any benefits. There is, apparently, no study in the literature that shows what proportion of a total stream population lives in Beaver dams and benefits from the temporarily better growth to be found in them.

6 Don't Beavers dislike the fast-flowing rivers and burns that are suitable for trout and salmon juveniles?

No. On smaller streams, the water velocities preferred by both Beavers and spawning Salmonids are similar. A Norwegian study actually found that Beavers preferred the Salmon spawning areas on small tributaries to colonise. This means that a map of where salmon spawn on smaller streams is also a map of where Beavers will prefer to set up home on such streams.

Parker & Ronning (2007) actually found that Beavers on smaller streams preferentially chose Salmon and Sea-trout spawning areas to set up colonies on, i.e. there were more often colonies in such areas than would be expected by random – and, obviously, when Beaver build dams it is in the areas that they colonise.

European Beavers build dams on streams with gradients of 1 to 2.5% (Hartmann & Tornlov, 2006) and Atlantic Salmon spawn in areas with gradients of 3% or less

(Hendry & Cragg-Hine, 2000). Canadian Beavers can build on gradients up to 4% (Hartmann & Tornlov, 2006).

In lowland river catchments spawning gravels are not confined to “fast flowing upland streams”, they are very widespread. Hartmann & Tornlov (2006) quote evidence that (Canadian) Beaver dams can affect 30-50% of the total length of 2nd to 4th order streams in Quebec. Fish have to be able to reach spawning gravels, so a dam anywhere on a stream, whether near gravels or not is a potential problem. A dam on a gentler, more downstream section would have to be passed by fish heading for upstream sections.

Preferred spawning velocities for salmon are, in fact, 0.25 to 0.90 metres per second (Hendry & Cragg-Hine, 2000). Beavers and spawning Salmon both like and dislike the same water velocities. Beavers prefer the tail ends of pools in which to build dams (Parker & Ronning, 2007) and these are exactly the sites that Salmon and trout prefer to spawn at.

The seriousness of the problems that can be caused by Beaver dams is highlighted by Beaver “activity” being listed as a threat to Sea-trout stocks in Lithuania (Kesminas, Leliuan & Rymantus, 2006). Sea-trout are considerably more agile than Salmon in reaching spawning grounds so any barrier that is a problem for Sea-trout is certainly a problem for Salmon.

7 Surely Beavers and salmonids co-existed in the same rivers for thousands of years before Beaver were exterminated?

Yes, but co-existence does not mean species not impacting on each other – all Predators and Prey “co-exist”, for example. Where there are fewer Salmon fry upstream of a Beaver dam than below because access by spawning adults is restricted, the species are “co-existing” but salmon are being impacted nevertheless. Of course the extent of that co-existence so long ago is not known. What we do know is that Salmon in particular are an important feature of our river ecosystems and rural economies and that they are under great pressure out at sea so require very careful management, where this is possible, which is during their fresh water phase.

When Beavers – and forests – were common in the Scottish landscape, Salmon and trout would have been restricted in their access into smaller streams by both Beaver dams and natural log jams. The return rates of Salmon from the sea in those days would have been much better than at present : In the 1960’s, when the first tagging of Salmon smolts was carried out, around 1 in 3 returned from the sea as adult Salmon. At present, it is less than 1 in 10, around 7-8%. In population terms therefore, 100,000 adult Salmon would have been produced by just 300,000 smolts in the 1960’s. Nowadays, to produce 100,000 adults needs over 1 million smolts. Juvenile Salmon are, basically, territorial so more smolt production needs more nursery area. Losses of nursery areas due to Beaver dams and other causes would not have been so critical in the past, when marine survival would have been so much better than at present. However, every square metre of nursery area for Salmon is needed nowadays which is why Salmon Fishery Boards and Trusts spend so much time and money on removing or easing obstacles to fish migration.

8 Salmon and Sea-trout can jump over waterfalls – surely they can get over Beaver dams?

No. Both Salmon and trout are good at jumping over obstacles but only if these have a good flow of water over the top of them and a deep pool below them. Beaver dams generally have neither. Although Sea-trout are actually better than Salmon at getting over barriers that require more of a “scramble” than a clean jump and there are places in Scotland where Sea-trout can pass and Salmon cannot, Beaver dams are a major problem for them in the Baltic countries.

Salmon require a concentrated flow of water which falls over an obstacle into a pool scoured by the falling water in order to jump; the depth of the pool needs to be around 1.25 times the height to be jumped. They use the undercurrent in the pool, created by the falling water, to make a "running jump" into the cascading water. It is the noise of falling water that attracts Salmon to the places where they jump; the most noise is made by the most water falling and that, of course, is where the waterfall is lowest.

Beaver dams, being created with logs and sticks, leak* and, except in spates have little or no flow over them which Salmon and trout can use to jump. Natural waterfalls have deep pools under them from which fish can jump; Beaver dams rarely have such features because they are not permanent and water goes through them, dissipating energy, rather than over them to create a drop with erosive power. Waterfalls have centuries / millennia to create deep water below them – Beaver dams do not.

* This is why legislation in Scotland requires dams and weirs to be watertight, so that water flow goes over their tops where it can be used by jumping fish and not through them, where it cannot.

9 Young Atlantic salmon have been found upstream of Beaver dams, does this still mean there is a problem?

Yes. All types of instream structure - fords, weirs, bridge foundations, etc. are more often partial barriers than total, i.e. they restrict fish passage rather than stop it altogether. This needs quantitative sampling to show – quantities of fish upstream and downstream of an obstacle need to be compared for a valid assessment to be made. Making such comparisons is standard fisheries management practice in Scotland – if survey work finds an average of 10 salmon fry per minute's sampling downstream of a weir and an average of 1 salmon per minute upstream of it, then it is clear that there is a problem even if there are salmon fry upstream of it every year. Over the years, the cumulative loss of breeding upstream of such a weir will increase in significance.The simple presence of young Salmon upstream of a Beaver dam can not therefore show that there is no problem. (see Appendix 2)

The law in Scotland requires "free" access for spawning salmon and sea-trout at instream structures at the times that they require it. Restricted access – i.e. fewer juveniles upstream than downstream – does not meet this requirement. While man-made weirs with fewer salmon fry upstream than downstream would therefore be illegal and would be required to be dealt with by Fishery Boards , Beaver dams causing similar problems would be protected by European law (and by a substantial section of British public opinion)

The effect of all types of instream structure also depends greatly on the amount of rainfall in Autumn, when Salmon and Sea-trout are migrating upstream into the headwaters. In a wet season, obstacles can be easy to pass, in a dry season, very difficult or impossible. Beaver dams, too, are not necessarily barriers in all years and in all places – it depends very much on the amount of rainfall during the short, final, period of fish migration when they are trying to enter smaller streams.

However on many rivers, especially the East Coast Rivers of Scotland, Autumn water flows are not reliable and migrating fish often have trouble reaching spawning grounds in smaller streams, even without any obstacles. Beaver dams would make such situations even worse. There is, however, very little information relating water flows to the degree of upstream penetration achieved by spawning fish –most comes from the Girnock Burn trap, run by Fisheries Research Services, Faskally, since the 1960's (also, see 10 below).

All instream structures (bridge foundations, weirs, fords, fish passes, etc.) can be barriers to fish movement especially in dry Autumns when these are more likely to be

total rather than partial. The only way to know if they are impediments or not, and to what degree, is quantitative sampling of salmonid juveniles upstream and downstream of them. Beaver dams are, from a fisheries management point of view, simply another class of instream structure and need to be subjected to the same examination. If this upstream / downstream quantitative sampling is not done, then it cannot be said if an instream structure is a total or partial obstacle or no obstacle at all. Such sampling has to be done at a range of water flows, in wet and dry Autumns. Without such sampling* no valid statements can be made as to whether Beaver dams are obstacles or not. Beaver dams can be the same size as man-made weirs or fords. It cannot be seriously suggested (though it has been) that while the latter two are often problems for fish migration, the former never are.

The only quantitative study of this sort concerning Beaver dams on a small tributary (Mitchell & Cunjak, 2007) found that the (Canadian) Beaver dams were obstacles to some degree in all but 2 out of 14 years, with dry Autumns making them total barriers.

While Scottish fisheries managers have, obviously, no experience of Beaver dams, they do have considerable experience of the other classes of instream structures and, in fact, spend a significant amount of their time and resources assessing the impacts of these on spawning runs and removing or easing those that are problems. In the absence of any evidence that Beaver dams are somehow completely different from other types of instream structure, the experience of Scottish fisheries managers with such structures must be considered relevant to their assessment of the situations that will be created by Beaver dams.

*See Appendix 2 for an example of this sort of assessment from the Teviot Water, a tributary of the Tweed.

10 Salmon and trout can reach even the most remote spawning grounds so surely Beaver dams would not be a real problem for them?

No. Despite their extreme agility both Salmon and trout often have difficulty reaching spawning grounds in smaller streams unless they get high enough spates at the right time in the Autumn; beaver dams would make such situations much worse.

A key issue from the point of view of fisheries management is that large, spawning, Salmon and trout adults can have considerable difficulty in entering smaller spawning tributaries and burns when Autumn rainfall is low. This has been shown, for Scotland, by the long-term study on Salmon spawning in the Girnock Burn on the Aberdeenshire Dee. The first information relating the numbers of Salmon managing to enter this tributary to the amount and pattern of water flow was given in Hay (1989). Recently this has been updated and extended by Tetzlaff *et al*. (2008), demonstrating the same point in more detail – that unless flows of the right quantity occur at the right time, entry of spawning Salmon can be restricted. As fish delayed by low flows become more "desperate" to enter the Girnock Burn, they will utilize smaller flows than they would have done earlier in the season. Instream structures such as Beaver dams would effectively remove this option to utilize less than ideal flows. Data on the relationship between water levels and the numbers of spawning Sea-trout running a small stream in the Tweed catchment is given in Appendix 2.

It was found that in the 2002/3 drought in Estonia, migrating trout could not pass downstream of Beaver dams and, along with other fish, became stranded in the small reservoirs above the dams and that most stranded fish did not survive. Those that did manage to migrate downstream were subsequently unable to migrate back upstream through the dams when flows came back up to normal. It was concluded that "*the beaver dams may seriously inhibit the restoration of riverine fish fauna after it has become extinct due to extreme climatic conditions (eg. drought) or other factors*". (Tambets M, et al. (2005). Amplification of negative impact of Beaver dams on fish

habitats of rivers in extreme climatic conditions. Journal of Fish Biology, 67 (Supplement B) 275-276).

11 Do Beavers cause problems in North America where there are / were a lot of Salmon?

Yes. Some benefits have been recorded for Coho Salmon, a Pacific Salmon species which lives on the west coast of North America and has different habitat requirements to the Atlantic Salmon which is Britain's native salmon. Beaver dams have been shown to restrict the migration of Atlantic Salmon in eastern Canada.

On the Pacific coast of North America, there are five species of Salmon, with very different habitat requirements as juveniles. Pink Salmon, for example, migrate to the sea straight after hatching. Coho Salmon either migrate directly to sea after hatching or move into pools in late Summer. While such pool-livers can benefit from Beaver ponds, this can only happen if Beaver dams do not restrict the access of the adult Coho (see www.skeenafisheries.ca/Beaver%20Dam%20Breaching%20Program%202004.pdf for an example of this happening). On the East coast of North America, there are Atlantic Salmon and the best study of the effects of Beaver dams on Salmon migration comes from that area (Mitchell & Cunjak, 2007). In this study, it was found that the complex of Beaver dams on the small tributary of the Miramichi (a major Canadian Salmon river) either totally or partially restricted spawning Salmon access in all but two out of 14 years, when the Autumns were particularly wet.

There are many reports on the sort of problems caused by Beaver dams in North America (to roads and forestry as well as fisheries) that can be found online bv searching for "Beaver" and "fish passage". or "Beaver" and "Culverts" for example.

12 Don't Salmon and Beavers live together in Norway where there are major Salmon fisheries?

No. The main Beaver and Salmon areas of Norway are in different parts of the country. The main Salmon rivers are in the west and north of Norway whilst Beavers are in the centre and east. In the south where Salmon have been wiped out of many rivers by acid rain, there is obviously little scope for interaction between the species. When Beavers do cause a problem in Norway they can be removed by hunting which was a prime reason for their introduction.

The physical differences between the Norwegian and Scottish landscapes must also be remembered. In steep, mountainous areas, Salmon spawning is largely confined to the main channels of rivers, which are too wide for Beavers to dam. Tributaries in such areas are generally too steep for Salmon to use or are blocked by waterfalls. In flatter landscapes however, tributaries are much more accessible to Salmon allowing them to spread through the landscape into streams only a couple of metres wide.

According to Parker & Ronning (2007) Beaver have not yet colonized the main Salmon and Sea-trout areas of Norway, in the northern and western areas but are still confined to southern and eastern area. This is supported by the distribution map of Beavers in Norway given in Halley & Bevanger (2005).

In the Norwegian Salmon catch statistics for 2007 (Official Statistics of Norway, D 397) the provinces with the longest established / original Beaver populations (Vest-Agder, Aust-Agder, and Telemark, in the South & East of the country) give, in fact, only the 6th, 14th and 15th ranking provincial catch totals out of the 16 salmon provinces of Norway. This does not suggest any great overlap between mature Beaver populations and Salmon fisheries.

According to a report published Online, on the 7th February 2008, by the Norwegian Pollution Control Authority: "*Acid rain has wiped out salmon in all the larger salmon rivers in the southernmost counties*(= provinces*)*". This being the case, it must follow that the scope for impacts of Beavers on Salmon in those southernmost provinces must be much reduced.

These same provincial catch statistics show that only one Norwegian province, Finnmark, in the extreme North, caught more Salmon than the River Tweed alone in Scotland. It has to be recalled though that some thirty Norwegian rivers on the West coast have lost their Salmon through the parasite *Gyrodactylus salaris* and those on the South have lost populations to Acid Rain. While these factors must depress Norwegian catch totals, the fact that a single Scottish river can catch more Salmon than all but one Norwegian province suggests very different situations.

The physical differences between Scottish and Norwegian landscapes also have to be remembered. The paper by Parker & Roenning (2007) entitled "*Low Potential for the Restraint of Anadromous Salmonid Reproduction by Beaver,* Castor fiber*, in the Numedalslagen catchment, Norway*" has been widely quoted as showing that Beaver pose no problems for spawning salmonids there and so would not be a problem in Scotland. However, it is made very clear in the paper itself that the topography of the study river (the Numedalslagen) is very different from that of typical Scottish East-coast Salmon river in that it occupies a steep "U-shaped" glacial trough in which Salmon can only use the main channel and the small sections of the tributaries that flow between the main river and the valley sides, the side streams being either too steep beyond the valley walls or having waterfalls there. This means that there is very little potential for Beaver impact on salmonids. This is a very different situation from a major Scottish, East-coast Salmon river, where the flatter landscape allows Salmon to penetrate far upstream in smaller tributaries. This difference between the Scottish and Norwegian situations is specifically made in this paper itself, where the authors say: "*As Scottish salmon appear to regularly use the headwaters of small streams for spawning to a greater degree than salmon in south-central Norway and Sweden, beaver dams there could have a greater potential effect on spawning activity than that observed in our study*."

13 Isn't the reason for the lack of studies on Beaver dams because there is not a problem to study?

No. Beaver dams are recognised as a problem for salmonids by many sources and specifically by The North Atlantic Salmon Conservation Organisation (NASCO). As said above, Beaver dams, from a fisheries management point of view, are simply a class of instream structure, like weirs, fords, dams, etc. and need to be assessed in the same, quantitative, way (see 11 above) good fisheries management cannot therefore dismiss them without investigation.

While Beaver are still to colonise major salmon areas in Europe, the control of Beavers is a major fisheries management issue in North America, where there is a large overlap between Beaver and Salmon. Many reports of the work needed to remove Beaver dams or discourage Beavers from building in particularly sensitive areas can be found online:- search for "Beaver" and "Fish Passage" for example.

The North Atlantic Salmon Conservation Organisation (NASCO) *Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat* CNL(01)51 includes the inventorying of "*A range of factors/activities that may adversely affect the productive capacity of a river*". These factors / activities are listed in a Table that includes:-

Category	Impact on Salmon Habitat	Activities That Could Cause These Impacts
Physical	Injury to fish, impaired access to	Man-made dams, culverts,

	spawning habitat and production areas, impaired outmigration to marine environment.	**Beaver** and debris **dams**, bridges, weirs, turbines, screens.

Beaver dams are therefore regarded by NASCO as having the same sort of potential to impact on Salmon as any other instream structure. All the member states of NASCO, including Norway and Sweden, should follow this advice.

In Sweden Beaver dams are not generally considered a problem. However when hydro dams were built on their main rivers in the early 20th century, fish passes were not generally built at dams, blocked nursery areas being "replaced" by hatcheries. This greatly reduced the extent of wild salmon populations.

A web search for "Beavers" and "Fish Passage" gives thousands of results and turns up many reports on work that has had to be done to ensure fish passage past Beaver dams. It is clear from these that problems are so common that such work is routine rather than a matter for research – to the extent that there are commercial companies offering the equipment needed for the various techniques that have been developed to try and solve such problems. It is not just fish passage, of course, that requires work at Beaver dams – road culverts are regarded as being useful, narrow, points in streams for dam building by Beavers, leading to the flooding of roads and property. Judging the issue by the number of studies on Beaver dams and fish passage in the scientific research literature is therefore misleading. Similarly, if a web search for "Weirs" and "Fish Passage" is carried out, thousands of results are again found, showing problems to be widespread, but few papers on weirs and fish passage are published in the research literature, again because the issue is a routine fisheries management issue rather than a research one.

14 As the Knapdale trial is in a remote location of Argyll, is there a risk to the important Trout and Salmon rivers either in the rest of Scotland or in England or Wales?

Yes. There may be few migratory fisheries at Knapdale so it is unlikely that the effects on them can be monitored in the trial. However Beavers are good parents and have the capacity to breed well and to spread rapidly if they are introduced. For example, in Sweden they have increased from 50 to 100,000 in 40 years. There are groups that want to make introductions in several places on the Island of Great Britain and wherever they start, beavers are likely to spread throughout the land mass where they will be protected by European legislation.

Beavers have been introduced to 24 other European countries since 1920 and have spread widely; the Scottish Wildlife Trust expects the Knapdale trial to be successful in terms of the criteria set for it. If beavers spread from the site, then as almost all streams in Scotland are spawning areas for Salmon and Trout and as numbers of beavers increase (which they can do at circa 16% per annum), the impacts (and dam numbers) will grow until the beaver population stabilises after 50 to 100 years at several tens of thousands, based on the experience of other countries.

Here are just two examples from Bavaria and Latvia.

EXPERIENCES WITH BEAVERS IN BAVARIA

Notes from a talk given by Gerhard Schwab at the Association of Rivers Trusts (ART) meeting at the Eden Centre, St. Austell, Cornwall, 9th November 2007.

1. Before the introduction to Bavaria it was thought Beavers would be limited to small amount of good habitat. Actually it has been found Beavers will live

anywhere with water and trees, including farm drainage ditches, as they create their own habitat. They have increased from 120 to 10,000 from 1966 to 2006 in Bavaria.

2. Beavers eat many farm crops, other than potatoes and asparagus. Sugar Beet is a favourite.
3. Beavers will live in culverts and drainage pipes, etc. which have to be fenced off with metal mesh to keep them out.
4. Beavers will burrow into embankments, etc. These have to be reinforced with metal mesh to stop this where it is dangerous.
5. Beavers are not afraid of human activity and will do what they want to make the landscape what they want; they are even found in urban environments now.
6. The best option to reduce problems in farmland has been found to have 20m buffer strips along watercourses. Beaver seldom go further than this, so any alterations they make don't impinge on the farmland beyond 20m.

FROM THE WEBSITE OF THE LATVIA INSTITUTE

Currently there are approximately 80,000 beavers in Latvia – that is, about six beaver pairs are active per 10 km2. A patient tourist has the chance to catch sight of a beaver. It is not definitely known why the number of beavers has increased so dramatically, but such population density is excessive – beavers dam up drainage ditches as well as small rivers and streams, and if the terrain is flat, large territories are flooded. We would gladly export some beavers if only buyers could be found.

15 If Beavers introduced to Britain did cause problems, could they be legally managed?

No. Wild Beavers are protected by European legislation. However once Beavers require "managing" then there is, by definition, a problem and any management of the problem will require funding; there can be no clear idea who will pay for this 50 years hence. Moreover some countries (Latvia, Estonia, Poland) have found that Beavers are actually rather difficult to control especially if lethal methods are not used. It is very unlikely that the British public would accept either hunting or shooting as acceptable, whatever the official position might be. Therefore it is unlikely that management could be an effective or economic solution to problems caused by Beavers.

Various guides to Beaver management have been produced in both North America and in Scandinavia. There are techniques for discouraging Beavers from building dams in places where these would cause problems – road culverts, for instance, attract Beavers to build dams because the stream is narrowed at such places. Large bore pipes can be inserted through Beaver dams to equalise the water levels on either side – as these are below water level, they do not create the noise of running water that would stimulate the Beaver to repair a breach in their dam. All these techniques however require major works and costs and constant maintenance. There is also the legal question arising from the fact that such techniques would cause "damage" to the habitat of a protected species. Nor has there been any discussion of who would bear the costs of such work – other countries have local or national "fisheries and wildlife services" who do this sort of thing, but Scotland has no equivalent agencies.

The question of whether it is "ethical" to introduce an animal, knowing that it will have to be killed to control it, has already been raised, demonstrating the cultural context in which any Beaver management would have to take place within the UK.

circumstances for the actions or omissions of other parties occasioned by their reading of this paper.

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