

Conservation  
of **Atlantic Salmon**



## Report on Study Tour to Denmark

**25<sup>th</sup> – 28<sup>th</sup> of September 2006**



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*Cover: The group of CASS delegates in Silkeborg, Denmark, accompanied by Hans Ole Hansen from the Danish Forest and Nature Agency (far right).*

## 1. The CASS LIFE project.

The Conservation of Atlantic salmon In Scotland (CASS) project is co-financed by the EC LIFE-Nature programme. The overall objective of the project is to safeguard and maintain the abundance and diversity of salmon in Scotland through the significant improvement of freshwater habitats, the development of management guidelines, and the promotion and demonstration of best practice in removal of key threats through joint working and partnership. The project has 17 partners with responsibilities for around 38% of the wild salmon resource, and is the single most significant salmon conservation project ever undertaken in Scotland. The project will significantly improve the natural freshwater habitat for salmon on 8 of the key salmon rivers in Scotland and provide a major vehicle for the raising of awareness of the needs of the species both to managers and a wider audience. It will produce a range of management demonstration products which will feed into wider conservation strategies for the species and guidance for application throughout Scotland and beyond.

The CASS LIFE project will:

- ❖ Halt the remaining commercial netting of salmon on 2 rivers
- ❖ Remove or bypass 25 obstacles improving access for salmon to 180km of habitat
- ❖ Improve over **39000m<sup>2</sup>** of freshwater habitat for spawning and juvenile salmon
- ❖ Restock restored areas of habitat with local populations of wild salmon on 3 rivers
- ❖ Control grazing along **38** km of river to improve river habitat and protect river banks
- ❖ Stabilise **2800m** of eroding riverbank and reduce siltation from surface runoff into two rivers
- ❖ Extend and diversify riparian woodland habitat along five rivers
- ❖ Provide general guidance and a local code of practice for gravel extraction in salmon rivers
- ❖ Raise awareness of *Natura* and salmon conservation issues with river owners and the public



## 2. Introduction to Study Tour

In 2005 a group of Danish fisheries scientists, river engineers and managers visited a number of the CASS LIFE project sites in Scotland, and made presentations about a number of riverine projects to assist salmon and other populations. The works that have been undertaken in Denmark, or are planned under the Houting LIFE project are addressing similar threats to those being undertaken in the CASS project, e.g. removal/bypassing of obstacles and riverine habitat restoration. Whilst similarities in addressing threats between Denmark and Scotland are obvious, the approaches taken to solve problems and the ecological circumstances are often very different, leading to learning opportunities on both sides.

In response to information obtained from this group, and the requirement for the CASS project to carry out a similar study tour under its Dissemination actions, the steering group proposed that a reciprocal study tour to Denmark would be extremely beneficial to CASS partners.

The study tour was arranged for September 2006, and was designed to allow our partners to consider fish conservation and habitat restoration issues from another perspective within the Natura network. It would serve not only to share best practice between regions but also to highlight different approaches within the study group themselves. The study tour was focused on the locations for action planned for the LIFE project to assist the Houting (summary below), but would also provide detailed information on a range of other actions.

The expected result from the study tour was for those involved in the project to appreciate the wider context of salmon conservation and learn from the experience of other projects. A report on the study tour would be produced and made available on the CASS website.

A detailed itinerary of the study tour is provided in the Appendix.

### The Danish Houting LIFE project

Title: Urgent actions for the Endangered Houting *Coregonus oxyrhynchus*



The project objective is to restore and maintain a favourable conservation status for the salmonid fish, the houting (*Coregonus oxyrhynchus*) in Danish rivers. The houting was previously distributed throughout the Wadden Sea but now is restricted to just six river systems in Denmark. The complex ecology makes the houting very vulnerable to disturbance. Small obstructions to movement in river systems can prevent their passage, and silting of spawning grounds and lack of suitable flooded meadow areas to act as nursery grounds for juveniles can limit their reproductive success. By working in partnership, the project will remove dams and weirs in four river systems and engineer solutions to allow houting passage. River sections will be restored with gravels to create spawning grounds, and flooded meadow nursery areas will be re-created.

### 3. List of Participants

#### CASS project partners:

The study tour was led by Colin Bull and included a representative from all the the major project partners involved in physical habitat and fish management actions. Individual accounts of the tour from the participants are provided in the Appendix.

Name	Position	Organisation
Colin Bull	CASS project manager	Scottish Natural Heritage
Brian Davidson	Assistant Director	Association of Salmon Fisheries Boards
Steve Hawkins	Bailiff	Esk District Salmon Fishery Board
James Hunt	Biologist	Tweed Foundation
Roger Knight	Director	Spey Fishery Board
Richard Millar	Project Officer	Galloway Fisheries Trust
Edwin Third	Head Bailiff	Dee District salmon Fishery Board

#### Participants from Danish organisations:

Name	Position	Organisation
Hans Ole Hansen	Biologist and Houting project manager	Lindet State Forest District
Ole Ottosen	Geologist	County of Southern Jutland
Hans Thil Nielsen	Biologist	County of Southern Jutland
Lene Kristensen	Civil engineer	County of Southern Jutland
Hans Harald Hansen	Biologist	County of Southern Jutland
Michael Møller Hansen	Biologist	Danish Institute for Fisheries Research
Gorm Rasmussen	Research Director	Danish Institute for Fisheries Research
Marianne Linnemann	Horticultural graduate	Oxbøl State Forest District
Søren Larsen	Fishery breeder	Danish Center for Wild Salmons

## 4. Report on Study tour

### Day 1: Monday 25/09/06:

First stop was at Ribe town to view locations for the Houting LIFE project sites on the River Ribe with Hans Ole Hansen. Houting (an anadromous salmonid fish) are completely prevented from passing through Ribe by three obstacles on channels in the centre of town. All have small fish passes (designed for salmon and trout) but due to houting's poorer swimming ability they cannot make use of these existing fish ways. The LIFE Project plans to focus flow into one of the three channels through Ribe town and engineer section to provide access for houting to suitable habitats upstream. The anticipated cost of the combined project works for fish passage (purchase of abstraction rights and physical works) is approximately equivalent to £530K.



*Left: one of the obstacles to fish movement in Ribe and the small wooden. Fish way. Right: Hans Ole Hansen describes the plans for engineering houting access in Ribe town to the CASS LIFE group.*

Previous drainage activities had established a 1.5m high impassable weir to regulate water levels at Bredebro. The proximity to an active railway crossing prevented the removal of the structure to allow fish passage. The solution was to establish four low gradient staged riffle areas across a 400m section downstream from the weir in order to overcome the height difference in a stepwise fashion up to the weir itself. Each riffle allows a small increase in streambed height, but no one riffle constitutes enough of a gradient change to prevent fish access. Wooden boards and careful placement of rock and gravel were used to create each riffle area, and they have also created spawning and nursery habitats for salmonid fish as well as addressing the obstacle itself. Finished in 1990, this fish passage solution cost the equivalent of £60K.



*Left: view from weir looking downstream to the staged riffle areas, and right, the original impassable weir now almost fully immersed in water as the downstream streambed has been stepped up to a level just below its crest.*

Ole Ottosen and Hans Ole Hansen described the large-scale re-meandering project carried out on the River Brede in several stages throughout the 1990's. In the 1950's this watercourse was straightened into canal-like sections and the bed lowered to increase discharge capacity and drain land for intensive agriculture. Additionally, concrete weirs were placed at regular intervals in the channel to prevent the river returning to its original course, but these prevented the free movement of fish. This impressive part-LIFE funded project has recreated 20kms of meandering watercourse to assist with nature conservation and either removed weirs, or converted them into riffle areas, allowing fish access again. Riparian landowners of the areas that are now only lightly-grazed and allowed to flood were offered compensation and in some cases additional high-quality land from a "land bank" established for this project. In addition to the re-meandering, several large wet meadow areas were established in order to reduce nutrients and oxidised iron (ochre) that originate in the drained agricultural lands upstream in the main watercourse and in turn the shallow Wadden Sea.

The section we viewed a project in 1994 to re-meander 3.2km of straight stream into 4.4km of channel and included the requirement for 60ha of adjacent land. In 1994 this project cost the equivalent of £270K.



*Left: one of the re-meanders on the River Brede. Middle: Ole Ottosen explains the process of establishing a wet meadow area to reduce nutrients entering the Wadden Sea. Right: Oxidised iron (ochre) visible in an inlet stream to one of the constructed wet meadow areas.*

In Tonder we were given an informative presentation on the biology of the Houting and the LIFE project by Hans Thiel Nielsen and shown the site of a current obstacle to their migration on the River Vida, right in the centre of town. A dam has created a large pond upstream, and a fish pass is present but impassable for houting. The water level in the pond upstream has to be maintained to ensure that the foundations of surrounding houses remain wetted and secure, so a solution has been designed whereby much of the existing pond will be retained but the dam will be replaced with a long lateral retaining wall separating the pond from a gradually sloping diversion channel along one edge. This diversion channel will connect the pond inlet and the existing location of the dam at the outflow with a gradual continuous slope that can be ascended by houting. Inflowing water is mostly guided through this channel but can also maintain a water level in the pond, over spilling the retaining wall to rejoin the channel once more in high flow events. The anticipated project costs associated with allowing fish passage at this location is equivalent to approximately £800K.



*The existing outflow from the pond in the centre of Tønder showing the sloping fish pass channel passing beneath the road from the dam at the other side. Right: The use of low-level concrete baffles to guide fish into the downstream entrance to the fish passage channel.*

**Day 2: Tuesday 26/09/06**

Lene Kristensen showed us the houting project site at Nørresø south of Tønder. Here creation of houting nursery habitat is being planned, with the movement of a dyke and re-establishment of meanders and flooded meadow habitat. Farmers will be paid compensation for the loss of their farmland. The estimated total costs of projects in this area to restore Houting nursery areas (engineering, earthworks, land purchase or allocation/swapping) are equivalent to approximately £860K.



*The weir on the River Sønderå (left) created to supply river water to a trout farm downstream (right) currently creates a barrier for fish movement*

The houting LIFE project will also address a barrier to movement at the Rens fish farm on the River Sønderå (a tributary of the River Vida). The existing out-take weir is to be retained at the owners request, despite his change to obtain his inlet water from a groundwater source and the redundant nature of the structure. The solution here will be to utilise the course of an existing bypass channel around this obstacle and engineer it to allow the majority of water through this low gradient route. The anticipated project costs for fish passage this location (survey, engineering works) are the equivalent of approximately £150K.



*The entrance to the small fish ladder located some distance from the obstacle itself , and the road crossing above the obstacle itself, where a diversion channel will be constructed that will retain wetland habitat upstream but allow houting access.*

We travelled on to another site where houting access is to be restored at a man-made dam on the River Sønderå. This 2m dam has created a large area of wetland upstream that has high value for wild birds, and has subsequently been designated as a European SPA. The obstacle does have a small fish ladder that is sometimes successfully used by salmon and trout, but it is too small and its entrance is difficult to find, located some 10m from the dam. Houting could not use this structure and are therefore prevented from accessing any further upstream. The solution here will involve the retention of the large area of wetland upstream and the establishment of a diversion channel along its edge, connected via a retaining wall to maintain water levels in the wetland. This low gradient channel will cross under the road (requiring a new bridge culvert) and empty into the large downstream pool. The actual project costs for this ambitious project have not been fully finalised but are estimated in the region of the equivalent of £800K.

Hans Harald Hansen joined us in Bov for lunch and then showed sites on the River Kruså where fish passage solutions have been created. The first of these new fish passage solutions has been made to allow salmonid fish access into a small lake where water exited through a mill and water wheel that was completely impassable for fish. Suitable spawning habitat for salmonids is present in an inflowing stream but access to it was not possible. The mill exit from the lake has recently been blocked by the creation of a concrete wall, over which floodwaters can spill if necessary. A completely new 200m long channel has been established to take water out of the lake and reconnect with the main river downstream from the mill. This channel has a shallow continuous gradient and also provides suitable spawning and nursery habitats for salmonids.



*Left: The original exit from the lake used to flow beneath the road and into a mill building. This has been blocked with a new stone weir that retains the lake level but allows high water levels to overspill and prevents flooding. Right: further around the lakeside, a new exit channel has been created and enters the lake just upstream from the new road culvert.*



*Left: An interpretation panel close to the diversion channel. Right: the man-made diversion channel looking downstream from the lake outflow. Boulders have been placed to provide flow variation and armouring.*

On the River Kruså by Kupfermühle, salmon and sea trout ascending from the Baltic Sea were prevented from passing the site of an old copper mill as the entire river was diverted through water wheels in the building complex. To address this, a new design of fauna pass (zigzag) was established in 1996. The principle behind the zigzag structure is to mimic natural meanders and to create the a long path for water and the greatest possible reduction in turbulence and flow rate, allowing even small fish and invertebrates to use the pass. The structure of the fish pass consists of a floor of triangle-shaped wedge sections which narrow from one side to the other alternately, creating a roughened surface with reduced flow velocity at the floor of the pass (consistently  $< 1\text{msec}^{-1}$ ) and regular resting areas for fish.



*Top left. The heavily weeded outflow section from the copper mill where salmon and sea trout are seen to gather before entering the fish pass. Top right: the group view the entrance to the zigzag pass beneath the mill buildings and have explanation by Hans Harald Hansen. Interpretation board visible to the left of the group. Bottom: the entrance to the zigzag fauna pass.*

In the River Haderslev Møllestrøm, a 2m high dam retains water in a large lake that is used for recreation and used to provide water to power mills. A fish pass channel was present but was ineffective as its entrance was far removed from the main water current, and the entire set of steps were enclosed and therefore in darkness. Restrictions were placed on the fish passage solution at this location by the proximity to the road and general urban setting. Sourcing funds to allow the required works to be undertaken was not possible until the opportunity arose to combine with essential repairs to the neighbouring road. The resulting works provided a gentle gradient diversion channel that flows out from the lake and turns 90° to flow along the full length of the original dam. This provides a long channel in which to gradually overcome a height differential. At normal water levels almost all the water is channelled down through this route. At elevated lake levels, water can overflow across the entire the face of the dam and enter directly into the channel via this route also, to prevent flooding. The total cost of the project here was the equivalent of £250K.

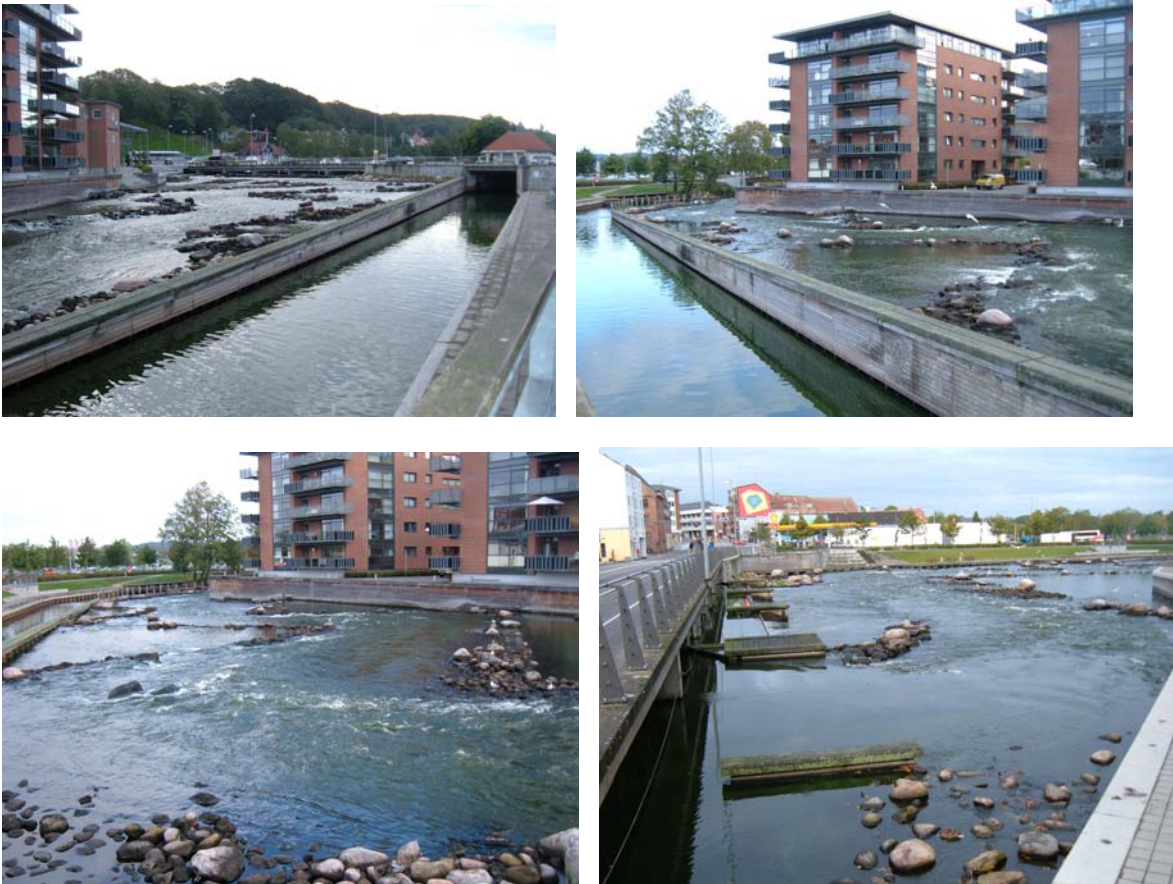


*The fauna passage solution on the River Haderslev Møllestrøm showing the outflow from the lake, low-gradient channel, dam wall to retain lake levels but allow flood waters passage, and proximity to buildings and road.*

**Day 3: Wednesday 27/09/06**

On the River Gudena in Silkeborg, Hans Ole Hansen described this project (the largest ever undertaken in Denmark) on the site of a former paper factory. The site has been developed into luxury accommodation and fauna passage in the river up into the large lake has been restored by the provision of a large gradually-sloping rock ramp to overcome the height difference between the lake and the out flowing River Gudena. This huge ramp is >30m wide and over 200m in length and incorporates channel deflectors to create a zigzag current and minimise current speeds. A channel to allow canoes and small boat access was also included alongside the fauna pass, separated by a wall that allows water to overflow from the ramp in high

flow conditions. The total costs of the fauna passage project in Silkeborg were equivalent to approximately £1.2M.



*The fauna pass on the River Gudena in the centre of Silkeborg viewed from downstream (top left) and from the outflow from the lake upstream. The engineered channel deflectors of anchored boulders are clearly visible in the low water conditions as is the separating wall and the canoe and small-boat channel. The site of the old paper mill has been developed into luxury apartment blocks on the right bank.*

Following the visit to the Silkeborg site we travelled to the Danish Forest and Nature Agency offices where a small workshop had been arranged. Short presentations were given by the Scottish delegates on our fisheries management structures and on the individual CASS LIFE actions being undertaken by partners. Michael Møller Hansen and Gorm Rasmussen from the Danish Institute for Fisheries Research Dept. of Inland Fisheries provided presentations on the conservation genetics of the houting in Denmark, and Danish freshwater fisheries management. An interesting discussion followed where much information was exchanged regarding the way fisheries and river habitat management activities and angling regulation are undertaken in our respective countries. Lunch was kindly provided at the Freshwater Centre where issues were further discussed with Gorm Rasmussen, followed by a brief visit to the impressive Danish Freshwater Aquarium AQUA, where houting were viewed.

We travelled to the Rover Skjern where the largest restoration project in Denmark has re-established wetlands and river features in a vast area that had been straightened and extensively drained with the aid of pumping stations, to provide land for intensive agriculture. With the help of EU funding the natural course of the river has been re-established and a large shallow lake created, providing valuable habitats for various forms of wildlife. In 2006, the total budget for works associated with the Skjern project (including interpretation and recreation facilities) is 284M DKK, the equivalent of £26M. 2002. Approximately £8M of this has been used on compensation to landowners, and 2/3 of the total cost has been borne by the state.

As part of the project, areas of salmonid habitat have been re-created in tributary spawning areas with the re-establishment of meanders and riffle features and a re-stocking programme to assist recovery is underway.



*Top: The River Skjern 3 km upstream from where it enters the Ringkøbing Fjord with re-created meanders. Bottom: The River Skjern project has re-created a large area of wetland that provides important habitat for migrating birds. Right: The roof of one of the pumping stations that once kept the water table down has been de-commissioned and now provides a convenient location for public interpretation and wildlife viewing.*

We then visited the River Skjern hatchery (The Danish Centre for Wild Salmon) where the hatchery manager, Søren Larsen, led a tour of the impressive purpose-built facility. He explained the stages in the supplementation stocking process from broodstock capture and DNA testing to ensure use of Skjern-strain fish is maintained, through to release of fry and parr. Careful disease management and meticulous hatchery operations at each stage ensures that very high survival rates are achieved.

Søren Larsen then made a presentation about the history of the Skjern salmon fishery and the role of the hatchery operation in its continued recovery. Then, along with Marianne Linnemann and Hans Ole Hansen, he answered questions from the group relating to the management of the salmon angling fishery on the River Skjern and regulation of the commercial (and prevention of the illegal) netting activities in the Ringkøbing Fjord. This interesting discussion illuminated several differences between the regulation of exploitation of adult salmon in Denmark and Scotland.



*The study tour group is shown the River Skjern hatchery where Skjern-strain salmon broodstock are stripped and their progeny reared for release back into the system to assist the recovery of the natural population.*

**Day 4 Thursday 28/09/06**

We travelled to the River Varde, where Hans Ole Hansen joined us once more to lead us around some sites, where access for houting is going to be restored and habitat quality is to be improved by the re-meandering of sections that have been straightened.



*River Varde: Left: The sluices and start of the canal that currently diverts riverwater into a lake from where hydro power is generated. This canal will be filled in during the houting LIFE project. Top right: A view from the dam on the River Varde created to maintain water levels in the canal and lake, with its small Denil-type wooden fishpass. This obstacle is to be completely removed and a 200m-long low-gradient riffle will be engineered at this location to allow houting to pass freely.*



*River Varde: The outflow from the lake at the power station. The lengthy step-pool fish way with undershot pipe connectors that currently functions to allow passage into the lake. This fishway would be retained to allow salmon and sea trout movement into the lake.*

A large canal has been made dug out and connected to the River Varde with water level controlled by sluices along with a 2m high dam in the main river (with small Denil-type fishpass). This canal provides water in a loop out of the river into a lake to allow electricity generation at Denmark's largest hydro-power station on its outflow. Water then re-joins the River Varde downstream. Water is currently still allowed to flow down the original River Varde course, but the flow is significantly reduced by the diversion to the lake. The generating station on the lake is small by Scottish standards and can only provide a fraction of the local energy needs. The economic driver to retain this type of electricity generating source is now no longer present. Fish passage into the lake is currently made possible through a long pool pass that switches-back over a distance of over 200m. The pass is used by ascending salmon and sea trout, but no counting facility is in place to quantify numbers or efficiency. Downstream-migrating smolts and kelts are screened from entering the turbines and use the fish pass. The fish pass is impassable to houting. The main purpose of the houting project on the River Varde will be to enable free passage for houting up into the catchment area that is currently blocked by the diversion of water via the canal, through the lake and fish pass. The project will remove the upstream weir and small fishway and re-grade a long section of riverbed upstream, allowing the creation of a riffle section of suitable low gradient to enable passage of houting. The canal will be filled in to allow all the water to remain in the course of the River Varde itself. The lake will therefore not receive any water from the River Varde, but lake levels will be maintained by water entering from separate small tributary streams. Water will be allowed to exit down the fish pass and join the River Varde downstream retaining the possibility with the possibility for salmon and trout passage up into the lake and its tributaries. However, with the removal of the canal and retention of water in the River Varde itself, the main water flow (and migration route for salmonids) will once more be in the river channel itself. The power station building will be decommissioned and demolished.

Although still uncertain, the anticipated costs for works on the River Varde associated with Houting passage are equivalent to approximately £3.4M.

## 5. Summary

The tour highlighted:

- that although landscape and scale of actions often differ markedly between Denmark and Scotland, that great similarities in approach and responses to problems for river habitat and fish population management exist.
- the huge investments being made at both a local and national level in Denmark in restoration schemes to re-instate natural features in river channels and the complex inter-relations between stakeholder groups and socio-economic restrictions / limits within which the actions can proceed
- the importance of large-scale investment by central government in land purchase to enable a “land-pool” from which sensible offers of compensation can be made to riparian landowners when developing nature conservation projects.
- the importance of planning and integration of several actions when developing projects to assist fish populations. This was particularly clear in the actions to restore connectivity between habitats for Houting management, as gaining access itself was not always enough, and specific nursery or spawning habitats were also required to be created.
- the importance of working to ensure natural, or semi-natural river flow regimes in creating and maintaining essential habitat patches for differing life-stages of fish.
- that large scale engineering work to restore landscape, and habitat quality in rivers and lakes can be carried out in the absence of an active salmonid fishery that is often seen in Scotland as the key economic driver for change.
- that similarly to the situation in Scotland, planning and implementing any action benefits greatly from community involvement and highlighted the need for dissemination actions to create a sense of community ownership. Co-operative working that keeps the involvement of stakeholders throughout the entire process appears to be the most effective way of creating long-term successes in such projects.
- that the use of low-gradient diversion channels to by-pass obstacles are preferable to species-specific prefabricated fish-passes in most locations, as they can be used by a greater range of fauna types. However, the engineering and liability costs associated with by-pass channel creation are often far higher preventing them from being a viable option at certain locations, particularly in Scotland where land ownership patterns differ greatly to Denmark.

that the fish and fisheries resources in Denmark are viewed as important and treasured national assets , with responsibility for their conservation being addressed more at a national level than in Scotland. Legislative powers for those involved in the coastal protection for migratory salmonids in Denmark differs from that in Scotland and the perceived incidence of illegal fishing in Denmark is lower than that being combated in Scotland.

## **6. Acknowledgements**

The CASS LIFE project would like to thank the following individuals and organisations for their assistance with the study tour:

Ole Ottosen, Hans Ole Hansen, Lene Kristensen, Hans Thiil Nielsen, Hans Harald Hansen, Michael Møller Hansen, Gorm Rasmussen, Marianne Linnemann, Søren Larsen.

The Danish Center for Wild Salmons, County of Southern Jutland, Danish Institute for Fisheries Research Dept. of Inland Fisheries, Danish Forest and Nature Agency Oxbøl State Forest District, Danish Forest and Nature Agency State Forest District of Lindet.

## Appendix 1

### Individual notes and experiences from CASS partner representatives

#### **Edwin Third : Head bailiff for the Dee District Salmon Fishery Board**

In Denmark around 95% of their rivers have been severely modified, with large canalization and drainage projects undertaken as late as the 1960's. Since the late 1980's the Danes have undertaken very ambitious restoration projects on their rivers and wetlands. These huge river engineering and restoration projects have been undertaken with the economics of fisheries playing only a minor part. The main reasons seemed to be the increased wildlife/landscape value, improvements in water quality, and the very endangered but economically unimportant Houting. This is a very different situation to that in Scotland, where the economic driver for works is often the large salmon fishery interests.

Restoration projects have involved lengthy negotiations and compensation for landowners for loss of land by giving them better land elsewhere, or buying the land. The Danish government has the power of compulsory purchase for this type of work. An interesting point was made by the Danes regarding landowners in that they target the size of each phase of a project to keep the number of landowners to a manageable level (around 6 – 10), as more than that number often leads to problems in their experience. I can relate to this, having to work with around 25 tenants and proprietors each year on the River Dee fencing, coppicing and silt trap projects.

Fish passage is a major fisheries issue in Denmark, despite the low gradients of rivers. Many old passes are inefficient and not suited to all fauna types. Traditional Denil and pool and weir type passes are being replaced by much larger and ambitious bypass channels often hundreds of metres long that allow passage for all species of fish and invertebrates as well as providing additional riffle habitat sections. The new zigzag design pass at the old copper mill at Krusaa looked useful.

In common with Scottish rivers, Danish rivers suffered in the past due to agricultural run-off, fish farm effluent, sewage input, industrial waste and ochre pollution resulting from land drainage. Water quality has been improving due to tighter environmental controls and the construction of drainage systems with ponds and wetlands to intercept nitrates, ochre and other chemicals. These actions have been found to be very successful as well as producing recreation areas, increased wildlife habitat, and visually enhancing the landscape.

The system of management and administration of rivers in Denmark seems to allow for a far more ambitious approach to river restoration than that currently operating in Scotland. The Danish national and local governments along with local private companies are working well in partnership to provide match funding for ambitious large-scale projects. The Danish projects appear to be well-provided for with technical support and expertise regarding river engineering.

Sediment loading in spawning areas is being reduced by creation of sediment traps in ditches and small watercourses by excavating deep holes which act as sediment traps. Seemingly very effective but the need for regular maintenance was clear. Similar to the silt trap project on the River Dee.

It was interesting to note that it is illegal in Denmark for livestock to have direct access to watercourse. Stock often use pasture type pumps. Fields with larger herds had several pumps. Pumps could be easily moved and relocated. Find out price/availability of pumps.

It was interesting to note that the Danish fisheries protection legislation seems far weaker than in Scotland. Although they do not perceive a problem at present, the options available for their controlling illegal coastal netting of migratory salmonids are limited.

### **Brian Davidson: Association of Salmon Fishery Boards**

This was a carefully constructed trip allowing us to make full use of the time allotted to us by our kind and friendly Danish colleagues who went well beyond the call of duty to show us their work. What we basically got was a whistle-stop tour of Denmark taking in miles of newly-meandered rivers with some man-made obstacles thrown in for good measure. The tour was both enjoyable in a social sense and extremely interesting from a professional point of view.

The main focus of the trip was the work being done to improve both access and spawning areas for the Houting on the east coast, a salmonid fish that differs from Atlantic salmon in that it is less powerful swimmer and unable to use fish passage solutions designed for other salmonids. The life cycle of the houting also requires extensive nursery areas for fry in the form of large areas of flooded wetland lower down the river catchment. Much of this habitat has been destroyed in Denmark through extensive historic land drainage works in the low lying areas where a constant battle was waged with keeping the sea off the land and ensuring the land was drained through a complex series of straightened rivers, drains, dykes and pumping stations. The houting is pretty much extinct in the Dutch/German river systems but small remnant populations remain in some Danish rivers draining into the North Sea. Today, the Danes are much more relaxed about their water resources in relation to intensive agricultural supply and, with substantial EU assistance, are restoring natural forms in rivers and carefully re-instating flooded wetlands for the houting to recolonise. There is some evidence that this is beginning to work. What was very apparent was how committed the Danish government is to providing and securing external funding for large-scale river projects. One project to re-meander the lower Skjern River exceeded the entire Scottish CASS LIFE budget.

Our visit also examined various obstructions within rivers, which was very pertinent to what we are doing in Scotland under LIFE, and it was interesting to see other (more expensive) solutions to problems. The Danes seem to be very enthusiastic about diverting rivers around obstacles and dams, as opposed to our view of trying to completely remove them or to create a conventional fish pass. We also viewed a state of the art hatchery facility on the upper Skjern where many thousands of fish are released at parr stage to support a fishery. Great care was taken here to ensure the genetic integrity of these fish, but I suspect that some fishery biologists in Scotland would keenly debate the overall requirement for such an operation.

Our hosts also arranged presentations from the Danish Institute for Fisheries Research and we gave talks to our Danish colleagues on the Scottish Fisheries set-up and the various LIFE projects. In return we received informative presentations about the genetic issues associated with the few remaining houting populations and fishery management in Denmark.

A few points were quite apparent at the end of the trip. The Danes have been very successful in securing large amounts of funding for fisheries and river work. This is in part due to the conservation status of the houting, but also reflects the 'community spirit', whereby many people work together, including local councils and the communities involved. This relationship or culture doesn't exist much in Scotland and I am sure we could learn something from this. Also, unlike Scotland, the driver for improving rivers and fisheries is a less-hard-edged economic one, but more about improving communities (but the fisheries benefit enormously). Also interesting was how little of their fishery licence fee was spent on administering the system (less than 10% of revenue), and how much co-operation and assistance was received from anglers in many fishery management disciplines – anglers whose fishery management training is funded by the state.

Many thanks to all who organised the trip, in particular Colin and Gill from the CASS Project and our friendly and enthusiastic Danish hosts, in particular Hans Ole Hansen.

**Richard Miller: Project Officer for Galloway Fisheries Trust**

On the 25-28th of September as part of the CASS Life project I attended the a study tour based mainly in Denmark but also briefly in Germany. The main focus of the tour was to learn about the various river restoration projects (many part-funded by the EC) that have been completed and for those that are planned to conserve the endangered species the Houting, and also to learn about techniques used in Denmark to aid salmonids passage over obstacles.

My personal knowledge of the Houting was very limited prior to the tour, but throughout the time spent travelling around the various examples of river works etc I learned a great deal about this important and rare species (e.g. life cycle, habitat requirements, distribution and movement constraints). Most of the tour was taken up learning how the various Danish government bodies in partnership, have restored river sections and fish passage, and how they are planning to re-create Houting nursery habitats by re-flooding areas of land that were once natural marshes and also by re-meandering stream channels. The remainder of the tour was filled by solutions of how to aid salmonids over obstacles, hatchery rear juveniles and how to create spawning beds.

As I manage the delivery of CASS LIFE actions on the river Bladnoch (which focuses on the restoration of salmon habitat) I found the Danish habitat restoration projects of particular relevance. On the river Bladnoch due to the effects of poor forestry in the headwaters and also agriculture practices in the lower reaches, large areas of spawning gravel have been lost or have become compacted. In Denmark we viewed areas of river bed that have been restored as spawning beds, I hope to try and use similar practices here in Scotland on a smaller scale to increase juvenile production.

Overall I found the study tour very informative and would encourage a similar event in the future.

**Steve Hawkins – Bailiff for the Esk District Salmon Fishery Board**

There were many similarities between the fisheries issues being faced (and addressed) by the Danes and those in many Scottish catchments. The Danish successes in re-establishing good quality habitat and addressing obstacles to fish movement can be held up to prove that if there are the resources and commitment, major habitat improvements and re-establishment actions can be achieved to the benefit of all wildlife.

The main points that the study tour highlighted for me were that:

1. The natural habitat for all the different life stages of your target (fish) species must be present and of suitable quality for a successful population to establish and prosper.
2. Man made obstacles can be successfully by-passed with ambitious and novel channel engineering solutions to allow free passage to migratory fish
3. With access to the proper resources (both financial and technical), the regeneration of highly modified instream habitats can be successfully conducted to support healthy fish populations.

### **Roger Knight: Director of The Spey Fishery Board**

As a newcomer to fishery management, albeit with a little knowledge of the CASS Life projects on the River Spey, it was interesting to see how Denmark had used the EC's Life funding to tackle their own particular problems. Denmark's river systems, and the problems that have arisen within them, are very different to the River Spey. Not only do the rivers differ in character, but also the scale of the projects undertaken in Denmark were vastly different to anything we have been able to do here.

The Skjern River Restoration Project had involved the remeandering of a river that had previously been straightened and dyked, recreating a natural wetland over some twenty-two square kilometres. The political and public consultation period for the Skjern project had lasted twelve years, and work to complete it a further three-and-a-half, at a cost of circa £28 million. It is almost inconceivable that the British Government, let alone the Scottish Executive, would consider such an extensive project to be undertaken essentially on the basis of environmental benefit.

One of the most impressive features of the Danish approach was that of "joined-up Government". National Government was working closely with local authorities and all other relevant stakeholders to achieve a coordinated solution to the country's water problems. This methodology, which has been a policy of the current British Government, has sadly remained largely aspirational.

A number of projects the Danes had undertaken were unique to Denmark and, whilst interesting to see, were not directly applicable to rivers such as the Spey. For example, gravel spawning beds for houting had been laid in a number of Danish rivers. These slow-flowing rivers are completely different in character to the Spey, for which a purpose-laid gravel bed is likely to be a nothing more than a temporary and transient feature.

I was particularly interested in the Zig-Zag Fauna Passage that had been employed at the Krusaa Tunnel valley. This provides a fish ladder that is adaptable to highly variable flows of water, whilst also providing a ladder that is suitable for a wide variety of fish species. This might not be directly applicable to the Spey at the moment, essentially because our statutory responsibilities are directed towards salmon and sea trout. But as our responsibilities under European Directives become more onerous, possibly requiring us to encompass non-native fish species as well, these fish passes could become increasingly attractive alternatives to competitors such as the Denil.

I was also interested in the methods employed to cut weeds on the Danish rivers. The use of a purpose-built dory-type boat with submersible cutters is a potential solution to the problem we have with ranunculus on the Spey. Whilst cutting ranunculus is not a solution for the long-term removal of the weed, it could provide a useful management tool in the short-term. Indeed, our Danish colleagues helpfully undertook to pass on details of the manufacturers of these boats for further investigation.

The visit was useful and worthwhile, although many of the projects we visited would not be directly transferable to the vastly different terrain and habitat of North East Scotland. But as an example of the environmental benefits that can be achieved when a government is genuinely determined to make improvements, Denmark must surely rank as a shining example.

### **James Hunt: Biologist for the Tweed Foundation**

The visit to obstruction projects at the Ribe, Vidaa and Norreso demonstrated the very different approach taken in Denmark to easing obstructions that cannot be removed due to the presence of structures such as housing or bridges further upstream. Instead of building fish passes (generally unsuitable for Houting passage), which is the default method in Scotland, the river bottom is built up to the lip of the obstruction with a slope of no more than 4%. Although an innovative idea, it was quite apparent that such projects were extremely expensive and often not necessary in Scotland when Salmon and Trout in Scotland can ascend well-designed fish passes. They would also perhaps be less practical due to the higher velocity of most rivers. However, there may be some situations in Scotland or UK where such a method may be required for rare species to ascend man made obstructions such as weirs.

The visit to re-meandering projects such as the River Brede project was inspiring to see considerable logistical problems overcome in order to restore the original river form. The general consensus of Scottish LIFE members on the tour was that it was still impractical to carry out such work due to the costs involved and the issues of land ownership, although the situation could change in the future if farming practises / subsidies were to change. It was also noted that canalised areas in Scotland would fail the basic good ecological status requirement for the water framework directive, but no discussions are taking place to consider funding / logistics for re-meandering such areas in the future. On Tweed, we are currently considering a map-based survey using old Ordnance Survey maps to at least identify canalised areas that could be targeted for re-meandering in the future.

It was quite apparent that the Danes were very successful in securing large sums of European money for Houting and re-meandering projects. In part, this was due to the low numbers of Houting in Danish rivers, which helped to receive extra funding, but it did appear that they were far more ambitious in the size of projects and associated funding.

The philosophy behind the funding was also very different - in Scotland, most work is carried out to improve numbers in the economically important Salmon and Trout. In Denmark, large amounts of money were often spent on projects that would derive very little economic benefit. It was the wildlife / restoration of the natural environment that was of primary importance e.g. Houting have negligible economic importance and the work at Kupfermühle would benefit Salmon and Sea Trout that support a very small fishery in the lake.

Our visit to the national hatchery produced very different opinions within the group. It was, no doubt, an exceptionally well-run hatchery. My personal issue with the system was that fish were raised in an artificial environment and were totally unsuited to coping with their sudden release into the harsh river environment. Introducing a natural feed before release would probably help survival rates and it was felt that raising the fish in a semi-natural environment where the focus was not on numbers produced but rather ability to exist in their new environment would have been far better. The very large sum of money creating and running the hatchery would have been better spent on addressing habitat problems. Experience from rivers like the Tweed is that Salmonid populations recover very quickly without a hatchery.

## **Appendix 2**

### **Detailed Itinerary**

#### **Day 1: Monday 25/09/06**

1. Arrive Esbjerg Airport at 12.40pm to be met by Hans Ole Hansen and pick up vehicle
2. Travel to Ribe town to view Houting project sites (Hans Ole Hansen)
3. Travel to Bredebro via the Island of Rømø to view the Wadden Sea (Hans Ole Hansen).
4. Travel to view River Brede remeandering project (Ole Ottosen).
5. Travel to Tønder for a presentation on the biology of the Houting (Hans Thiil Nielsen)
6. View obstacle on River Vidaa in Tønder, one of the project sites in the Houting-project (Hans Thiil Nielsen)
7. Accommodation in Tønder.

#### **Day 2: Tuesday 26/09/06**

1. View Houting project sites at Nørresø south of Tønder and an obstacle in River Sønderå east of Tønder. (Lene Kristensen and Ole Ottosen).
2. Travel to lunch in Bov (Lene Kristensen, Ole Ottosen and Hans Harald Hansen participated).
3. View two fauna passes in River Kruså by Kupfermühle (Hans Harald Hansen).
4. Travel to view a fauna pass by a former obstacle in River Haderslev Møllestrøm (Ole Ottosen).
5. Accommodation in Silkeborg.

#### **Day 3: Wednesday 27/09/06:**

1. View the new fauna passage in Silkeborg on the River Gudena (Hans Ole Hansen).
2. Mini-symposium at Danish Forest and Nature Agency office in Silkeborg with papers from Gorm Rasmussen and Michael Møller Hansen from Danish of the Institute for Fisheries Research Dept. of Inland Fisheries.
3. Lunch at the Freshwater Center (Hans Ole Hansen and Gorm Rasmussen participate)
4. Brief visit to the freshwater aquarium AQUA
5. Travel to view several sites on the River Skjern restoration project (Marianne Linnemann, Hans Ole Hansen).
6. Travel to River Skjern salmon hatchery (Soren Larsen, Marianne Linnemann, Hans Ole Hansen)
6. Accommodation in Varde.

#### **Day 4: Thursday 28/09/06**

1. Travel to view several Houting-project sites on the River Varde (Hans Ole Hansen)
2. Travel to Esbjerg Airport departing at 13.40pm