SHAD AND STURGEON IN THE GIRONDE, SW FRANCE .

REPORT OF A STUDY VISIT : SEPTEMBER 26-29 , 1994

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Report to Scottish Natural Heritage

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INTRODUCTION

The allis shad *Alosa alosa* and twaite shad *Alosa fallax*, two of Britain's ten rarest species of fish, are listed in Annex II and Annex V of the EC Habitats and Species Directive. EC member states are thus required to propose candidate sites for designation as Special Areas of Conservation for these two species, establish necessary conservation measures and undertake monitoring of their conservation status.

A study of shad and smelt in the Cree Estuary and along the Solway Coast, SW Scotland by the authors of this report (SNH Contract: SNH/11B/93/AEB) has raised a number of problems which it has not been possible to answer by local research. A review of the literature and regular correspondence with contacts in France indicated that a visit there would provide a valuable opportunity to see shad habitat and discuss problems with several scientists who are involved in shad research.

Both European species of shad, the allis shad and the twaite shad, have declined substantially in recent years and the large rivers of western France are one of the remaining strongholds of these fish - especially the allis shad. The Gironde Estuary and its main rivers, the Garonne and the Dordogne, is probably the most important of these systems and considerable research has been carried out there recently by CEMAGREF (Bordeaux), LAM (Montauban) and ENSAT (Toulouse). Figure 1 shows the Gironde Estuary and the main river sections of interest; also shown are the locations visited.

The common sturgeon *Acipenser sturio* is also protected under the EC Habitats and Species Directive as a 'priority' species. As it now occurs only very rarely in UK waters, conservation measures under this Directive are not at present being considered for this species in the UK. However, given the extreme rarity of common sturgeon and the fact that the Gironde seems to be the only river which this species now enters to breed, the opportunity was taken during this study tour to visit the CEMAGREF fish conservation facility where serious efforts are being made to save this species from extinction.

FRENCH RESEARCH GROUPS

CEMAGREF, Bordeaux

The Centre National du Machinisme Agricole du Génie Rural des Eaux et des Forêts (CEMAGREF) is the French Institute of Agricultural and Environmental Engineering Research and has nine large laboratories in different parts of France. In the CEMAGREF laboratory in Bordeaux, the Fisheries and Aquaculture Division is concerned with research into fisheries and fish farming in both fresh and brackish water. Studies include modelling the population dynamics of both shad species in the Gironde system. Several of the CEMAGREF staff in Bordeaux have been involved in shad research in recent years and useful discussions and exchanges of information (see Appendix 1) took place there during the visit.

LAM, Montauban; ENSAT, Toulouse

For some years, a programme of research of allis shad in the River Garonne has been carried out by a group of scientists based at Montauban (Lycée Agricole de Montauban) and Toulouse (ENSAT Laboratoire d'Ichtyologie). They have identified the principal spawning grounds of allis shad and part of the river where they spawn is now a nature reserve (see below). A full day was spent with this group looking at and discussing various aspects of the biology of allis shad in the Garonne.

ALLIS AND TWAITE SHAD

The main objective of the study visit was to obtain information about the habitat and environmental requirements for shad spawning (in the Garonne River) for comparison with the conditions found in rivers on the Solway Coast in SW Scotland to enable a better estimate of the suitability of the Scottish rivers for shad spawning.

In the Gironde Estuary there is a considerable commercial fishery for shad, but it is almost entirely focussed on allis shad which are preferred to twaite shad by the consumer. Before the summer spawning seasons both species are at sea where allis shad tend to be found in deeper waters and feed on plankton, whereas twaite shad feed mainly on small fish. Twaite shad enter the Gironde

Estuary in early summer and are there for some time before spawning in the tidal freshwater section of the Garonne, within 30 km of the river mouth. Allis shad are at sea until they are ready to ascend the river some 150 km to their spawning grounds (see below).

Agen spawning grounds

The River Garonne at Agen is a major spawning location for allis shad and a 1.4 km stretch there has been notified as a nature reserve (Réserve Naturelle de la frayère d'Agen), primarily to protect the spawning grounds. Allis shad spawn mainly in a 200 m stretch of river beside Agen, though some fish spawn 20 km upstream at Lamajistère, and beyond. Allis shad spawn in fast running water (see Table 1) over a clean substrate of gravel and pebbles, avoiding silted areas. The actual location of spawning within the river changed at Agen due to gravel extraction which, since the establishment of the reserve, is no longer permitted. It is not clear what actually triggers spawning (it does not appear to be daylength) but observations have shown synchronised spawning at both Agen and Lamajistère. At the height of spawning activity, fish spawn at both sites and at some places in between; at other times only the two main sites are used.

The main spawning period is in July, although some spawning can occur from mid-May to August. The fish spawn between midnight and 0600h (mostly 0230-0330h). Most of the males present are ripe, but the females, who ovulate repeatedly over short periods, move in and out of the area. Overall, however, the male : female ratio is 1 : 1. During spawning, pairs of fish swim near the surface splashing vigorously and leaving a bubble trail: the process is well known locally as the 'bull'. Observers on the river bank can estimate the numbers of spawning pairs by counting the numbers of separate 'bull' splashes on the surface. Also, a microphone mounted on a tall pole beside the river (with associated equipment nearby) automatically records the distinctive noise from 'bull' events. The results from direct counts and sound recordings are combined to produce a final estimate of the spawning population. In 1994 there were 21,000 'spawning events' - not the same as the numbers of fish as they spawn several times.

Immediately after spawning, the eggs (2 mm diameter) drift downstream, sinking into cavities in the gravel/pebble substrate. At Agen, eggs drift up to a maximum of 100 m downstream but at Lamajistere they may drift as much as 2000 m, presumably due to a more turbulent flow regime

there. Egg drift has been measured by using anchored nets, or simply bricks with holes and a net backing. Densities of eggs on the river bed have been estimated at *ca* 100 m^{-2}. Incubation in the substrate takes about 4 days and survival rates are low (16%). Following spawning, most adult fish die.

Fishing by anglers is restricted to short periods in the morning (06.00-08.00h) and evening. There is no fishing at night. Dead or dying fish may be eaten by piscivorous birds, but there is apparently no significant increase in the numbers of these birds at this time. Annual reports of the work carried out there by local research groups are available (e.g. Cassou-Leins *et al.*, 1988; Cassou-Leins & Carette, 1994).

NOTE: The visit to Agen by the authors and scientists from CEMAGREF stimulated sufficient local interest to merit coverage by the French press. An example of the resultant articles is given in Appendix 2.

Golfech shad lift

Ten kilometres above Agen there is a major dam on the Garonne to provide water for the Golfech Nuclear Power Station. Though this station operates a closed recirculating cooling water system, for safety reasons an adjacent water supply is needed in case of failure. The dam is also used for hydro-electric generation and because it is a major obstacle to a variety of important migratory fish (river lamprey, allis shad, Atlantic salmon and sea trout) a mechanical fish lift (Figure 2) has been incorporated.

Shad arrive when the water temperature is above 12°C, normally 17-18°C. Fish migrating upstream are attracted to the lower entry of the lift by water discharging from the entry channel at *ca* 300 cm s^{-1}. Gates at the entry close periodically (trapping any fish in the channel) and are drawn back along the channel forcing fish into a lift at the base of a 22 m high tower. The lift operates every 10 minutes during the shad migration period (but only every 2 hours at the time of our visit). At the top of the tower fish are discharged into another channel (length: 250 m; current: *ca* 50 cm s^{-1}) which connects with the river above the dam.

Within the upper channel there is an observation chamber where video recording equipment automatically identifies and counts the numbers of fish using the lift. In 1994, the count of allis shad migrating upstream through the lift was 86,300.

Juvenile shad migrating downstream do so through the main (generating) flow through the dam turbines. They can be caught in the deep water chambers of the dam by lowering a clamp net (closed) to about 5-7 m into the water and then raising it (open). Several 0+ allis shad were caught and photographed during the visit.

Dordogne system

Many of the tributaries of the Rivers Garonne and Dordogne, though suitable for shad, are blocked by dams. However, fish passes and lifts are being introduced and tested at several of these. The Rivers Isle and Dronne are major tributaries of the River Dordogne and both are blocked by dams at various places. Water quality in both these rivers tends to be poor due to vineyard effluents which have high nutrient and organic loads.

The town of Libourne is at the confluence of the Rivers Dordogne and Isle and the system here is still tidal with a range of 2-3 m. There is a fishery here for shad (and lampreys) using drifting trammel nets (any salmon or sea trout caught must be released). Glass eels are also fished, using scoop nets.

On the River Isle at Lombardemont there is a weir (220 cm high) which is impassable to shad and lampreys, though glass eels can negotiate it. It is planned to lower the height of the weir and install a fish ladder in 1995. Downstream of the weir (from the weir to the River Dronne junction), the river is a nature reserve and no fishing is allowed. Both allis shad and river lamprey spawn in this stretch.

On the River Dronne at Coutras there is another weir which is impassable for shad and lampreys. Here too, both allis shad and river lampreys spawn just downstream of the weir. There are eight further weirs between Coutras and St Seurin (see Figure 1).

Gironde Estuary

Juvenile shad

The Gironde Estuary is *ca* 100 km long and about 10 km at its widest point and is a major nursery area for both allis and twaite shad as well as several other important commercial species (see Appendix 1). It is also an important fishing ground for a variety of fish and for shrimps. At present, 18 shrimp boats operate here but they take such a high bycatch of juvenile fish that it is planned to phase these boats out completely.

Several hours were spent on one of the shrimp boats near Port Maubert observing the fishing procedures. Boom nets (mesh *ca.* 8 mm) operate on either side of the anchored boat for varying periods, depending on tidal currents. Periodically the nets are lifted and the mixed catch is emptied into an open box and sorted immediately. Important commercial fish species, particularly bass, are removed and released. Other species (which include large numbers of gobies and pipefish) are killed during the process of washing and cooking the white shrimp.

The catches seen included large numbers of 0+ allis and twaite shad and an excellent sample of these was collected and brought back to Scotland. In addition, small numbers of 0+ smelt were taken, but these were thin and in poor condition. Apparently the population of this species in the Gironde has collapsed recently, for unknown reasons. Specimens of smelt were also retained to compare with fish in Scotland.

STURGEON CONSERVATION

Present status

The common sturgeon *Acipenser sturio* is a large anadromous fish which was formerly of considerable commercial importance in many parts of Europe. However, like other species of sturgeon, it is very vulnerable to overfishing, pollution and barriers to migration and in recent years has undergone serious decline. Formerly occurring widely in European coastal waters from southern Norway to the Adriatic, it had spawning populations in many of the major rivers entering this region. The decline has been so serious in the last decade that the Gironde seems to be the last remaining river which this species now enters to breed (in very small numbers). However,

there is no record of spawning since 1988 and it is likely that this species will become extinct in the next decade.

CREA facility at St Seurin (Crea is a French pseudonym for sturgeon)

CEMAGREF are making a serious attempt to save this species from extinction and have established an excellent fish conservation facility beside the River Isle at St Seurin. The primary objective here is the conservation of *Acipenser sturio* and in preparation for this the facility has already developed breeding and rearing techniques for other (less endangered) sturgeon species - the sterlet *Acipenser ruthenus* and the Siberian sturgeon *Acipenser baeri* have now been taken through a full life cycle at St Seurin. There are now several commercial farms for the latter species in France.

Acipenser sturio is now so rare that specimens are treated on an individual basis. At the time of our visit, there were just six fish of this species at St Seurin, though efforts are being made to obtain others. Of these fish, one (length: 157 cm; weight: *ca* 15 kg) was 12-13 years old, another (length: 145 cm; weight *ca* 7 kg) was 10 years old whilst the four others (lengths: 110-115 cm; weights *ca* 5 kg) were about 5 years old. The difficulties of eventually breeding from just these six fish are immense - for example, it will be 5-10 years before the younger fish are mature enough to spawn.

Future prospects

The prospects for the future of this species look poor and it is important that as much support as possible is given to this conservation project by other countries in Europe. Some of the work is supported through the EC and the possibility of providing help to obtain further stock for CREA through British fishermen is under discussion at the moment.

DISCUSSION

This study visit provided an invaluable insight to the habitat and biology of shad and to the research in the Gironde system. Many points of relevance to the Solway shad project arose during the discussions with French colleagues, of which the following are the most relevant.

1. There are substantial differences in the reproductive migration of the two shad species. Allis shad come in fairly quickly from the sea and migrate upriver well above the tidal zone, spawning only once in their lifetime. Twaite shad enter the estuary and spawn in the upper (freshwater) tidal area; they are multispawning. This behavioural division between the two species may not be universal since observations in Welsh rivers show that twaite shad migrate over 50 km upstream to spawn - well above the tidal limit.

   The lengths of tidal reaches in the River Cree, and other Solway rivers, are very much shorter than in the Gironde system, so time spent by migrating/spawning fish would be less in the Solway rivers. Also, access to the freshwater sections above the tidal limits would be achieved more quickly. Thus, if shad are spawning in the Solway area, migration patterns may differ from those in France.

2. A significant number of allis and twaite shad from the Solway have fully developed gonads in an apparently, immediate pre-spawning condition. Photographs of these fish and their gonads were shown to the French scientists who agreed that this was the case, thus confirming the presence in the Solway of both species of shad fully prepared to spawn and emphasising the likelihood of their doing so.

3. The passage of allis shad into sections of the Gironde system is blocked by weirs. However, these weirs appear mostly to be higher than, for example, the weir on the River Cree at Newton Stewart, which, in the opinion of the French scientists, is probably passable to allis shad which are stronger swimmers than twaite shad. However, some obstacles on Solway rivers (e.g. the hydro-electric dam on the River Dee near the tidal limit) are certainly impassable to shad. Since twaite shad spawn in the tidal zones of the Gironde system, the Bordeaux scientists have no knowledge of their ability to ascend weirs - though they are known to ascend minor obstacles in the River Rhone in southern France.

4. It is believed that water temperature is an important trigger to both shad species for their entry into the rivers. Though spawning in the Gironde mostly takes place at around 18°C

and above, entry to fresh water may occur at 12°C. Records of Solway river temperatures are being examined in this respect, and such information should give useful criteria for determining potential migration/spawning periods. Preliminary analyses indicates that suitable spawning temperatures for shad are achieved in Solway rivers during most summers.

5. The young of both species move into the lower (saline) estuary after a few months and occur there with various other species. The 0+ shad at this stage are relatively easy to distinguish from similar species such as sprat and herring. The opportunity to examine first hand the young of these three species together was invaluable for confirming the identification of young clupeids collected in the estuarine/tidal reaches of the River Cree and a good collection of type material is now available for use in the Solway project. The Gironde fishing also confirmed that sampling undertaken previously by the authors in such sections of the River Cree and other Solway rivers was wholly appropriate.

6. The possibility of Solway shad being stray French fish searching for their natal river was discussed. However, since there are identifiable differences between the shad of the Gironde and the relatively nearby River Loire, indicating a spatial restriction, it therefore seems unlikely that this could be the case. Most evidence to date indicates that shad (of both species) return to their natal streams to spawn - thus emphasising the likelihood of mature shad in the Solway spawning somewhere in the vicinity.

Overall a much greater understanding of features relating to shad migration capabilities, their spawning requirements and performance, scientific study methods, and the status and conservation of common sturgeon was achieved through participation in this study visit.

Further information describing the relevance of these findings to the Solway shad project will be included in the final report 'Shad and Smelt in the Cree Estuary', to be presented to SNH by the authors of the present report in March 1995.

ACKNOWLEDGEMENTS

This visit was supported by Scottish Natural Heritage. The arrangements in France were made by Dr Eric Rochard (CEMAGREF) and we are extremely grateful to him for all his help and support during our stay. We are also most grateful to the following for help and information during our visit: Jean Jacques Cassou-Leins, Jean Luc Bellariva, Delphine Martin, Catherine Taverny, Mario Lepage, Jean Marie Delpeyroux.

Table 1: The River Garonne at Agen.

Water temperature range:	8-28°C
Temperature at spawning:	12-26°C
Current speed at spawning:	*ca* 100 cm s^{-1}
Spawning depth:	150-200 cm
Water quality:	Class 2
Water clarity:	Turbid

Table 2: The Gironde Estuary

Water temperature range:	8-23°C
Salinity in summer:	15-18 ppt
Salinity in autumn:	10-13 ppt
Water clarity:	Turbid
Substrate:	Firm mud and gravel

Figure 1: A map of the Gironde Estuary and lower sections of the Garonne and Dordogne Rivers showing the locations visited.

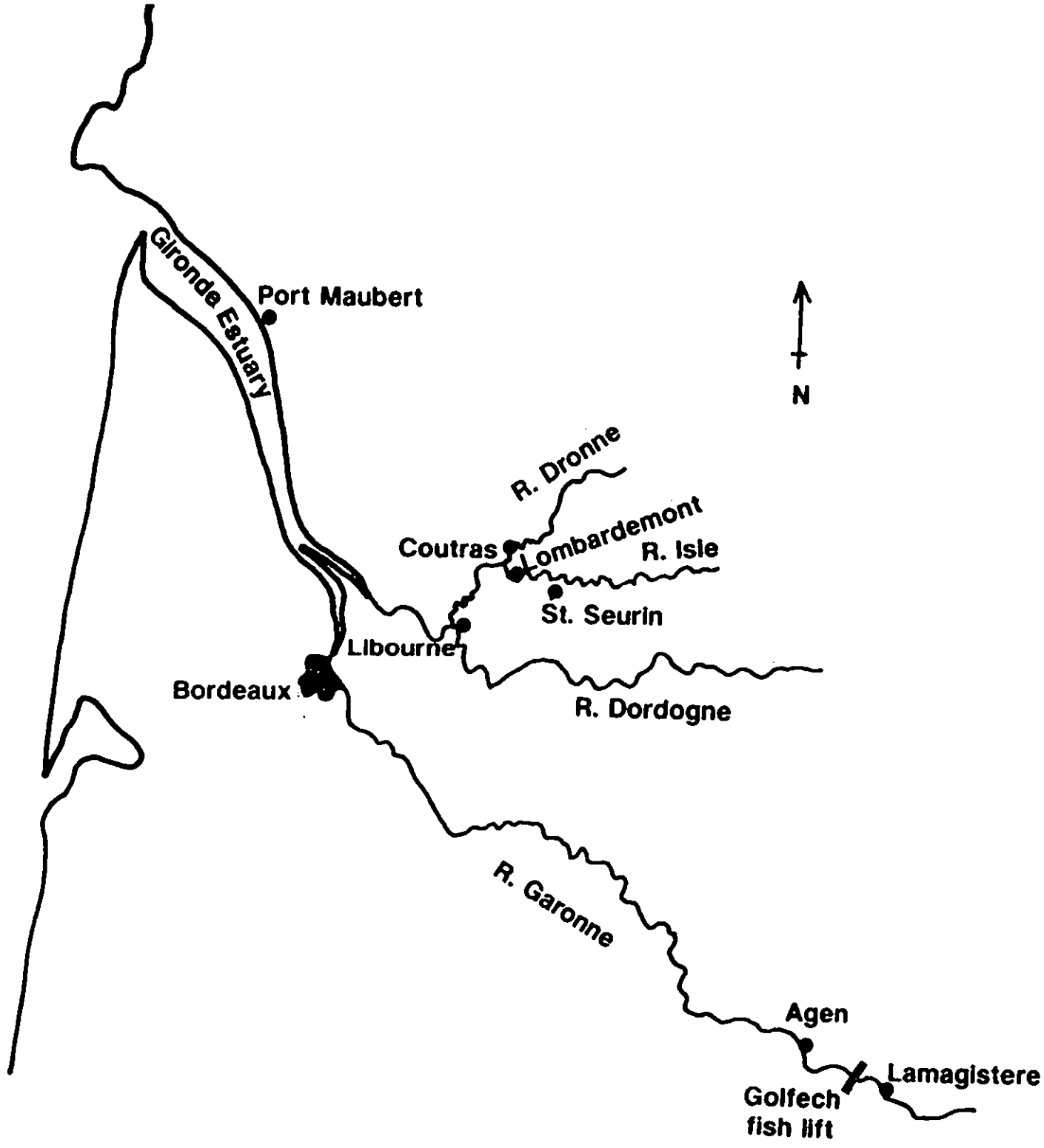
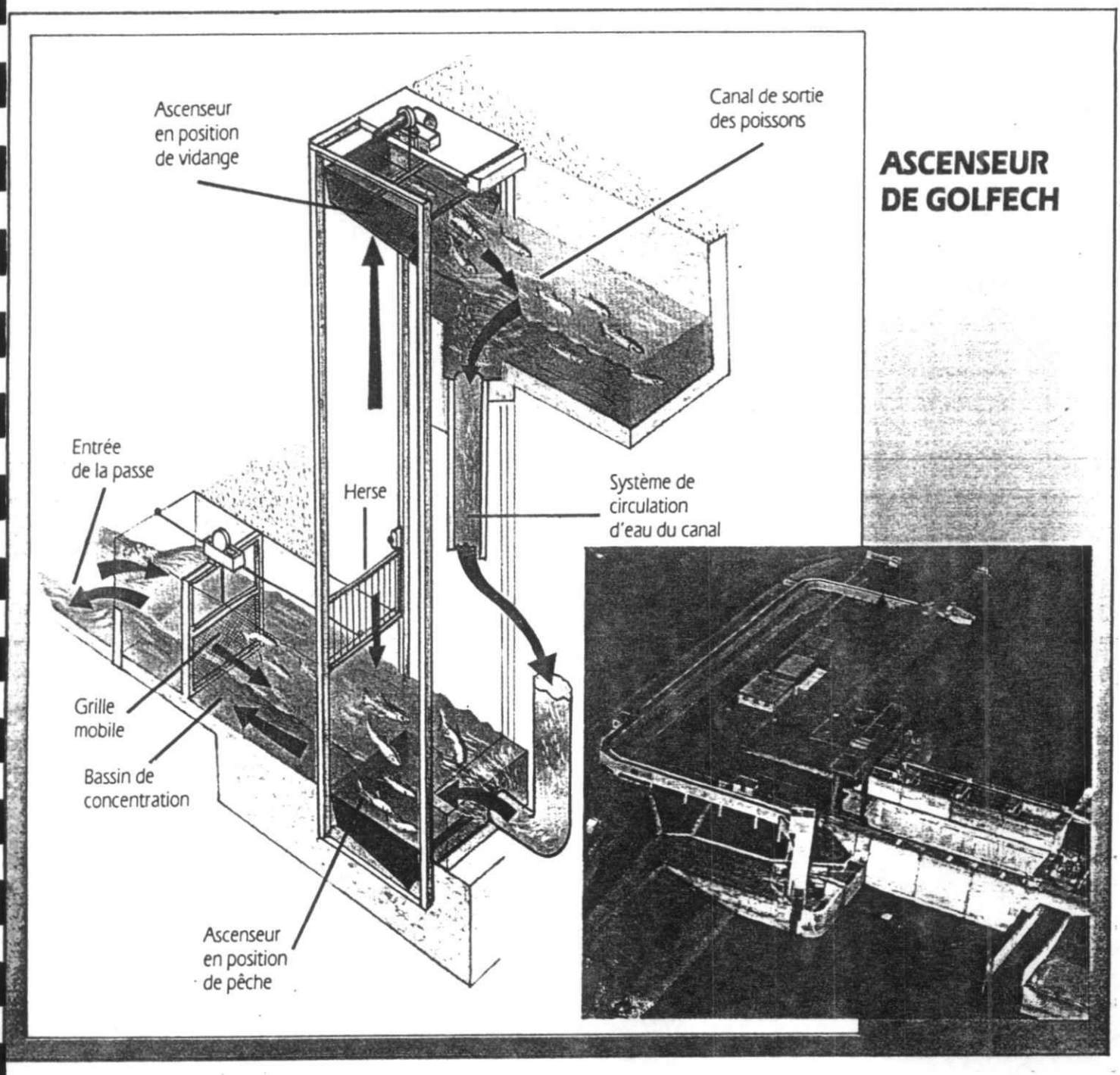


Figure 2: An illustration of the fish lift at Golfech nuclear power station dam.



Appendix 1. Reference material obtained during visit.

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CONSEIL SUPERIEUR DE LA PECHE. Undated. Decouvre la vie de la riviere. Bordeaux, Conseil Superieur de la Peche. *A very basic, well illustrated booklet explaining in simple layperson's terms the aquatic life of a river and the importance of catchment-river relationships.*

ELECTRICITE DE FRANCE. 1991. Un Ascenseur sur la Garonne. Toulouse, Electricite de France. *Leaflet about the fish lift (for salmonids, shad and other species) at the nuclear power station dam on the Garonne.*

ELECTRICITE DE FRANCE. 1994. Golfech. La Garonne & ses Poissons. Toulouse, Electricite de France. *A leaflet about the Golfech fish lift and the counts of fish through it from 1987-1993.*

Appendix 2

Soc cu 28/9/94

Sud-Ouest 28/9/94

PÊCHE ET ENVIRONNEMENT

Une maison pour l'alose ?

La venue de trois chercheurs écossais sur le site de la frayère d'alose agenaise donne l'occasion d'évoquer la perspective de la création d'une maison de l'alose

Une bibliothèque, un centre d'animation pédagogique, un pôle consacré à l'histoire des recherches entreprises sur ce grand migrateur... C'est ainsi que l'Association de la frayère d'alose agenaise imagine l'avenir de la maison de l'éclusier vers laquelle court le « cordon ombilical » du comptage des « bull ». Cette perspective a été évoquée, hier, par Alain Carette, Pierre Marty, respectivement secrétaire et président de l'association à l'occasion de la visite de trois chercheurs écossais venus apprécier, sur le terrain, ce qui est fait à Agen pour mieux cerner les habitudes domestiques du poisson d'argent.

Piloté par Jean-Jacques Cassou-Leins, professeur au lycée agricole de Montauban et chercheur à l'ENSAT (Ecole nationale supérieure nationale d'agronomie de Toulouse), par Alain Carette et Pierre Marty, les trois chercheurs — Karen Sweetman, Peter Maitland et Alex Lyle — ont ainsi longé les berges de Garonne, rive gauche, entre le Pont-Canal et le Pont de Pierre et se sont fait expliquer comment, au printemps revenu, les chercheurs et les passionnés enregistrent les bruits générés par les tumultueuses amours des aloses pour procéder au comptage des poissons.

Les Ecossais et l'alose ? Le poisson d'argent n'est pas un inconnu pour les pêcheurs du nord de la Grande-Bretagne : on pêche là-bas les aloses feintes, celles-la même qui, en Garonne, remontent jusqu'à La Réole, mais n'accomplissent pas le long pèlerinage qui mène la grande alose jusqu'aux eaux de l'Ariège.

Sur ce chemin, les graviers de Garonne où, depuis des années, les aloses ont repris leurs habitudes.

Les trois chercheurs écossais en compagnie de MM. Pierre Marty, Alain Carette, Jean-Jacques Cassou-Leins et des scientifiques du CEMAGREF : un parcours de reconnaissance sur la rive gauche de la Garonne, en bordure de la frayère d'alose

(Photo Patrick Bernière, « Sud-Ouest »)

C'était naguère entre Beauregard et le Pont de Pierre. Cela se passe maintenant un peu en aval : conséquence des extractions et des modifications du lit de Garonne que ces prélèvements ont généré.

Qu'en sera-t-il demain ? On ne doute pas, chez les membres de l'Association de gestion de la réserve naturelle que la rupture de barrage de Beauregard ait demain quelque influence sur le comportement des aloses. Et l'on a déjà vérifié, cette saison, que le barrage en question n'est plus l'obstacle qu'il fut : on a dénombré dix fois plus d'aloses à Lamagistère quand les comptages étaient marqués, à Agen, par une nette stabilité.

Trois chercheurs du CEM GREF, Eric Rochard, Mario I page et Delphine Martin, accom gnaient les Ecossais dans l approche des mystères de l'alose

BEAUREGARD

La brèche préservée

La nature a été plus forte : on le sait, Garonne a creusé un bras, rive gauche, à hauteur du barrage de Beauregard. Fallait-il combler ? Il semble bien que cette hypothèse ait été abandonnée et que l'on s'achemine vers une stabilisation du site. Un enrochement sera nécessaire, ne serait-ce que pour préserver les terrains des riverains. Mais le barrage de Beauregard ne sera pas rétabli. Et l'on peut même présumer qu'il finira par céder, à long terme, à la force des eaux de Garonne.