A PRELIMINARY TELEMETRY INVESTIGATION ON THE OBSTACLES TO ANADROMOUS SALMONIDS MIGRATION IN SPAWNING STREAMS OF THE BELGIAN ARDENNES (RIVER MEUSE BASIN)

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ABSTRACT

In the course of the 'Meuse Salmon 2000' programme aiming at the restoration of the Atlantic salmon *Salmo salar* and sea trout *Salmo trutta* in the River Meuse Basin, most large dams are progressively equipped with fishways to restore the free circulation of spawners between the North Sea and the first major spawning streams, the River Ourthe and its tributaries. Spawners entering the River Ourthe would still be confronted to so-called minor obstacles, aiming at water regulation for tourism purposes but of which the actual impact on fish migration has never been investigated. In order to test for the actual free-circulation of salmonid spawners in the upper River Ourthe and to locate potential spawning grounds, a probe fish (489 mm FL male sea trout) was tagged with an intraperitoneally implanted radio-transmitter. From the 18th of ovember 1995 onwards, the trout was tracked in a part of the river (44 km upstream of the confluence) which was thought to be devoid of any major obstacle to fish migration. Three days after its release, the trout had migrated over 6 km up to a small weir (1.8 m high). During four consecutive days, the trout was consistently located downstream of the weir but no successful climbing was observed, reflecting the poor efficiency of the central fishpass under dry weather conditions during summer and autumn. The trout then settled in a deep run habitat, 150 m downstream of the weir and no upstream excursion was recorded until the first major rise of water level, four weeks later, even when the weir was opened for water regulation purposes. When the water level was maximum (24th of December), the trout moved upstream of the weir and migrated over 28 km during the next 72 hours up to a spot identified as a potential spawning redd from habitat features, and where it was consistently located till the 31st of December. These results, though most preliminary, clearly indicate that even minor obstacles may cause a substantial lag in trout migration of which the impact on spawning success remains to be determined. Since similar minor man-made obstacles are most frequent in the salmonid spawning streams of the Belgian Ardennes, it is thus uncertain that migratory trout having successfully climbed the major obstacles since the North Sea would find their way to the spawning redds. As a corollary, it is suggested that more detailed case studies should be undertaken, ideally via the use of telemetered probe-fish, in order to provide management policies that would represent a suitable compromise between users of water resources with apparently conflicting interests (water regulation, tourism, nature conservancy).

KEY-WORDS: Hydraulic Works / Dam influence / *Salmo trutta* L. / Migration / Radio-tracking / Belgium.

INTRODUCTION

The Atlantic salmon *Salmo salar* and the sea trout *Salmo trutta trutta* of the river Meuse Basin, which once represented an important natural resource in Belgium, The Netherlands and France, have totally disappeared from this river basin since the 1930's. This extinction was mainly due to water pollution and the building of weirs and dams for navigation, hydropower generation and river regulation purposes. Significant efforts have been made to improve the water quality and the restocking of juveniles gave encouraging results. However huge weirs and dams still compromise the successful recolonisation of the river basin by adults. In the course of the

'Meuse Salmon 2000' programme aiming at the restoration of these species in the River Meuse Basin (Philippart, 1985; Philippart *et al*., 1990; Philippart *et al*.., 1994, Philippart *et al*., 1996), most large dams are progressively equipped with fishways to restore the free circulation of spawners between the North Sea and the first major spawning streams, the River Ourthe and its tributaries (figure 1). Spawners entering the River Ourthe would still be confronted to so-called minor obstacles, aiming at water regulation for tourism purposes but of which the actual impact on fish migration has never been investigated. The aim of this preliminary study was to describe the behaviour of trout facing these so-called minor obstacles in order to test for their real impact on migration patterns.

METHODS

Study Area

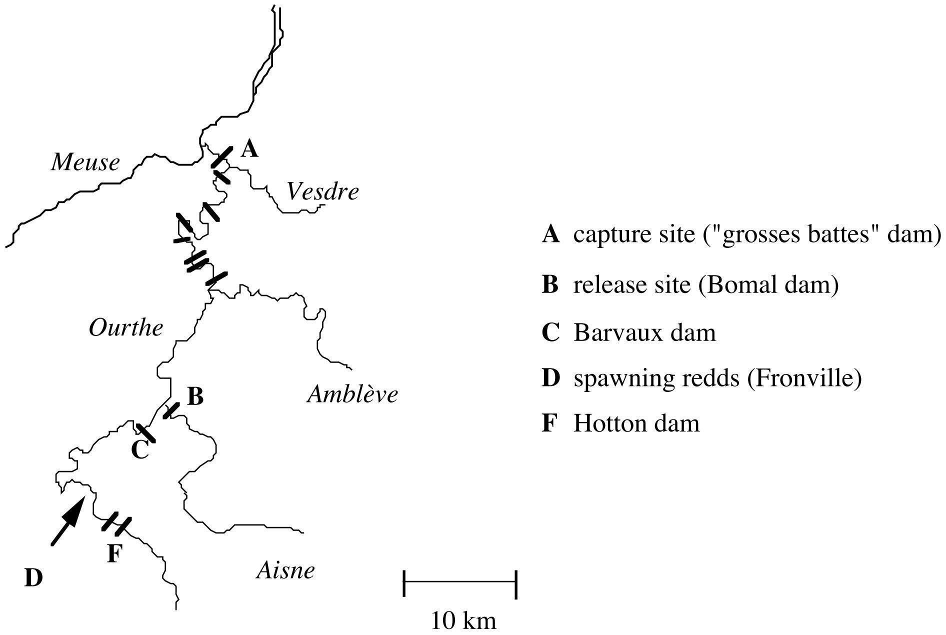

Figure 1: Map of the study area, the River Ourthe sub-basin

The study was conducted in the Belgian Ardennes, in the main tributary of the River Meuse, the River Ourthe and one of its sub-tributaries, the Aisne stream (figure 1). The study site was located in between the villages of Bomal and Hotton even thought to be devoid of any major obstacle to fish circulation. Water temperature and level fluctuations were measured daily (0.1°C and 1 cm reading accuracy, respectively). Water flow data were communicated by the SETY (Ministry of Equipment and Transport, Walloon Region).

Fish tagging

On the 17th of November 1995, a wild sea trout (male, 489 mm FL) was captured by electrofishing (EPMC generator, 2.5 KVA, DC) just downstream of the "Grosses Battes" dam on the River Ourthe. The fish was then transferred 45 km upstream, equipped with a 40 MHz activity radio transmitter (BE-512 model; ATS, Inc.) then released 200 m downstream of a small dam in the Aisne stream (figure 1).

The implantation procedure of the transmitter went as followed. The trout was anaesthetised with a 0.25ml l^{-1} solution of 2-phenoxy-ethanol. Once it had reached the tolerance stage (± 5 min), it was placed upside down into a support made of wet paper, that was adjusted to its shape (R.S. McKinley, Univ. Waterloo, Canada, pers. comm.), always making sure its gills were kept under the anaesthetic solution . A midventral incision was made between the pelvic girdle and the papilla, with its length minimised (±3 cm in average) to enable the passage of the alcohol sterilised transmitter with a slight external pressure. The incision was closed by two separate stitches, 9-10 mm apart, using sterile catgut (2.0 Dec) on cutting needles. The trout recovered its posture and swimming around 3 min after surgery and was transferred to the study area .

The trout could be detected at a maximum distance of 500 m (depending on local environment). It was located every day since the 21st of November 1995 with a Fieldmaster radio receiver and a loop antenna (ATS) and its position was determined by triangulation. It was located to an accuracy of $2m^2$ by reference to labelled marks on the banks of the river (at the time the trout was downstream of the Barvaux dam). Locations were carried out as frequently as every 2 to 10 min during the tracking.

RESULTS AND DISCUSSION

Once the trout was released, no obvious deviance from normal behaviour was observed as long as it was located (± 2 hours). The next day, the trout had left the tributary and started migratory upstream the river Ourthe. On the 21st of November 1995, the trout was found just 400 m downstream of a small mobile dam (Barvaux dam, see figure 1). This small dam (1.3 m high), constituted of two separate parts which can be elevated or lowered via hydraulic arms, is equipped with a central fish pass consisting of 7 successive 1 m^3 pools (plate 1).

During the next three days, the trout was located below the dam and on two occasions, it was observed trying to clear it, but in vain. Precise locations were undertaken in order to understand the behaviour of the trout as it faced the obstacle and to detect whether the trout would use the fish pass or not to clear it. It was obvious that the fish pass did not attract the fish which was mainly located near the left weir or near a sewer on the left hand bank (figure 2). In addition, if the trout would have found the entrance to the fish pass, it would further had to leap into it as the first pool was about 20 cm above the river level due to extremely low autumnal rains. Similar observations were made on each tracking day until the 24th of November 1995. From the 25th to the 28th of November, the trout was located about 100 m downstream of the dam and no more attempts to clear the dam were observed. On the next day, the trout moved another 100 m downstream into a deep run habitat (suitable habitat for adult trout). During the following weeks, it was consistently located in this habitat, only leaving it for short excursions (± 30 m) which were regarded as feeding behaviour. The situation remained unchanged until the 22nd of December despite the mobile dam had been lowered 9 days earlier for water regulation purposes. As a matter of fact, the trout did not move until the water level started increasing on the 23d of December 1995 when we located it 60 m downstream of the dam and just below the dam on the next day (figure 3).

On Christmas day, it cleared the dam and was located 2.5 km upstream. The mean water flow increased from 5.3 m^3s^{-1} on the 20th of December to 65.8 m^3s^{-1} on the 24th of December then decreased to 61.8 m^3s^{-1} on the 25th of December. From the moment the dam was cleared, the length of upstream daily journeys increased substantially: 2.5, 12.5 and 13 km on the 25, 26 and 27th of December respectively. On the next day, the trout was located on the edge of a potential spawning redd (in Fronville, see figures 1 and 3) where it remained until the 31st of December 1995. No spawning activity was detected at the time of the day (13:00-17:40 h) when the trout was located.

Plate 1: Downstream view of the Barvaux dam

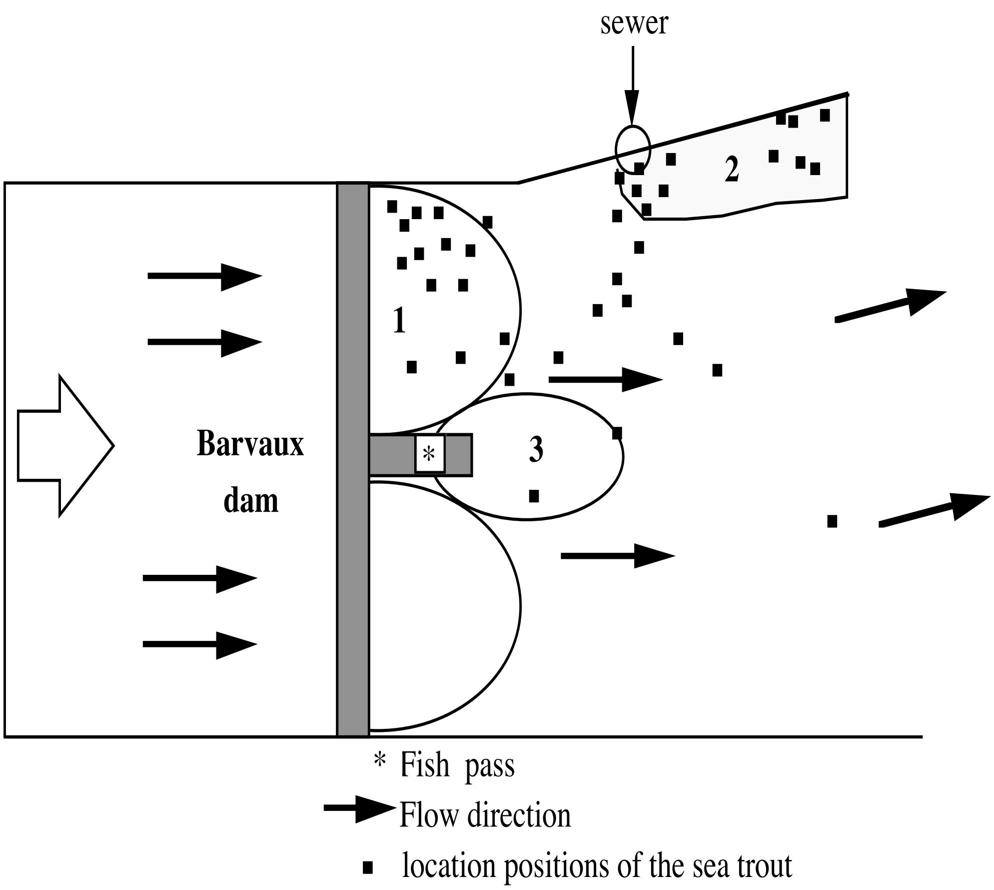

Figure 2: Locations of the radio tracked sea trout below Barvaux Dam on the 23^d of November 1995 (Julian day 326) in between 13:07 and 15:06 h. The influence areas of spillways, sewer and fish pass are represented by ellipses and numbers 1, 2 and 3, respectively.

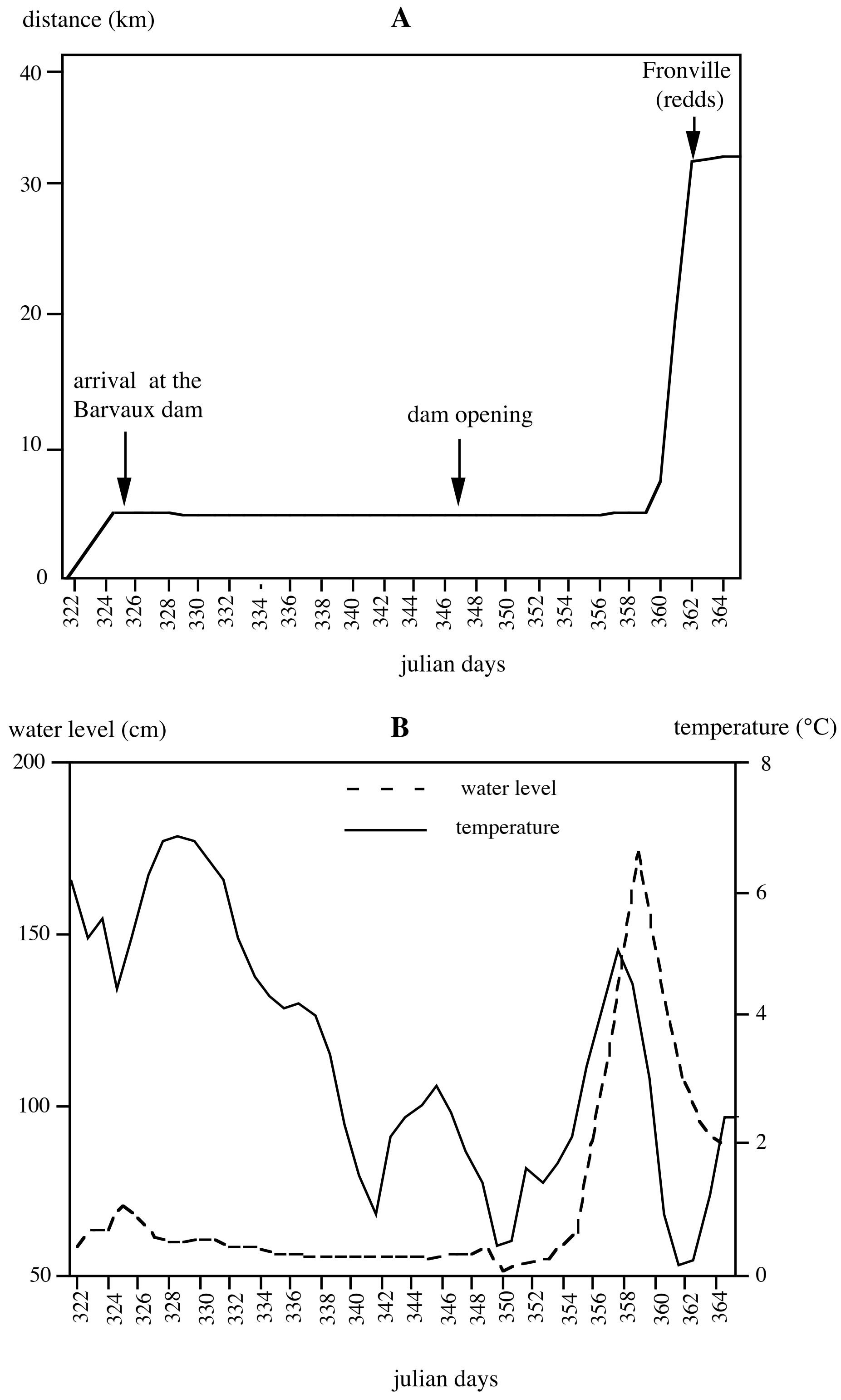

Figure 3: A. Daily movements of the radio tracked trout related to its release site, from the 18th of November 1995 (julian day 321) to the 1st of January 1996 (julian day 1). Point (321,0) corresponds to the release site (Bomal dam). B. Variations of water level (cm) and temperature (°C) in the River Ourthe during the study.

Further tracking (January-late March) indicated that the trout resumed its upstream migration from the moment water temperature was above 3°C. It travelled to a second dam (1 m high) in Hotton (figure 3) which it did not clear, probably due to low water levels. It then moved 2 km downstream and settled in this area until the third decade of March 1996, when it started a downstream migration down to Barvaux. Most movements were favoured by high water levels but their lengths were substantially less at low temperature.

CONCLUSIONS

This preliminary study using a probe fish (*Salmo trutta* L.) clearly shows how a small dam, thought to be insignificant towards the free movements of fish, can disrupt and/or enable the upstream spawning migration of anadromous Salmonids. These first results also show that this is not a local problem (limited to the Barvaux dam) as a similar problem was observed at the Hotton dam during the study. Therefore, the locations of the trout near the dam made by a precise telemetry tracking technique, enabled us to understand that the interruption of the migration would be due to a mismatch in the conception of the fish pass, at least in its functioning under low water levels. Since Salmonid spawners enter tributaries or resume their spawning migration in early autumn, it would be crucial that these mobile weirs be lowered as early as the end of October (if the meteorological conditions would permit it) to enable the free access to spawning redds. The creation of all these small dams in the study area is a result of increasing tourism activity, with dams mainly aiming to maintain minimum levels for water sports during spring and summer, when the water levels are usually low. The natural richness of the region developed its attraction for tourism activity but the increasing success of tourism nowadays imperils nature conservancy, essentially because all users and managers of water resources are not conscious of their own impact on these resources. In order to provide comprehensive information to resources users, detailed investigations should be undertaken to analyse interactions which were thought to be insignificant at first sight but could prove more serious in the long run, as suggested by this telemetry study on the impact of small dams on migration patterns of trout.

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