

Study on by-pass system on Downstream migration of eels

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Introduction

The downstream migration of eels is impeded by numerous dams on rivers. Hydroelectric dams and water reservoirs reduce breeder stocks and delay eel migration (Acou, in press). The development of by-pass systems should improve escapement for downstream migration. Many studies were realised for diadromous freshwater spawners, there are scarce for eels.

In this work, a pipe of a major dam was modified to permit the transit of eels. A net at the exit of the pipe permits to catch migrants and to study the downstream transit. Simultaneously, another trap was surveyed 1 km downstream to analyse the efficiency of the by-pass.

The site

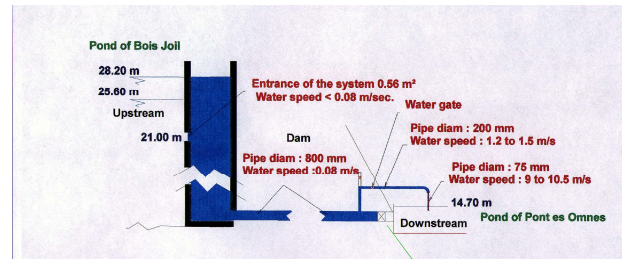
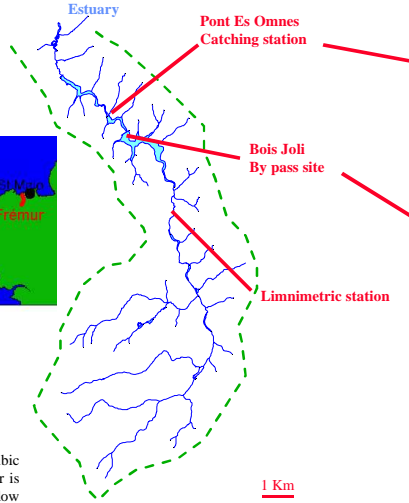
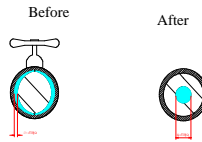
A major dam was built across the Frémur for drinking water. The reservoir is about 59 hectares and 3 Millions cubic meters. The maximal water elevation is 13.70 m. During the winter the water level increases until the reservoir is full. Then, water flows over the top of the weir. Because of the low discharge of the river, the filling up is very low providing that the water consumption is higher than the discharge. This year the overflow December 14. A the natural water discharge is monitored immediately upstream the pond. Downstream migration of the silver eels is also monitored at the outlet of the system (Pont es Omnes trap).

By Pass modification

To mitigate the impact of the dam on the downstream part of the river, a minimal discharge is always restituted to the river (40 liters/sec) with a devoted pipe. It is in connection with the reservoir with a small water gate (section 0.56 m², level : 21.00 m), and with pipes of different diameters. At the end of the pipe, the diameter is reduced to 200 mm, the water discharge is regulated by a water gate. It is half opened to obtain the required discharge and therefore provokes 100% kills.

Dead eels were observed at the exit of the pipe. In 1998, we modified the flow control system with a reduction of the pipe diameter, now the diameter at the exit is reduced to 75 mm and the water gate is fully open.

Water discharge control



Pipe reduction and Net to control the by pass (6 m long, 0.50 m in diam, mesh size : 2 mm)

A net is settled at the exit of the pipe (6 meter long, 0.50 m in diameter, mesh size 2 mm) it is emptied twice to sixth each week. The study began October to January 18. It stopped when the net was torn up, 40 samples were collected. For each of them, eels were counted, individual biometric characteristics were measured and sanitary observations were made. Alive eels were stocked in a tank for three days to assess differed mortality. After they were released downstream the dam. Forty eels were PIT tagged and released before December 2.

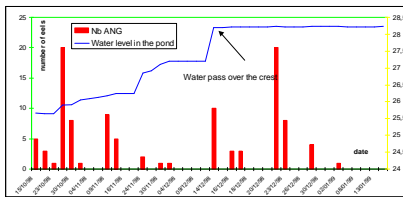
RESULTS

1. Use of the By-Pass

Eels find the entrance of the by-pass in spite of :

- The small section (0.56 m²)
- The depth of the entrance between : 4.80 and 7.20 meters deep according to the water level in the reservoir
- The small speed of the water at the entrance (> 0.08 m/sec.)

Eels continued to use the by-pass when the water overflowed.

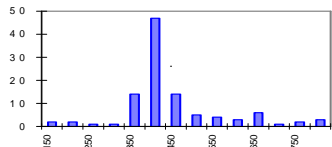


Water level in the pond and yield of eel in the by-pass

2. Selectivity

1. The by-pass was used by silver eels (101/105 individuals), only 4% of yellow eels, like at Pont es Omnes trap.
2. There is no significant size difference between eels caught in the by pass and Pont es Omnes's trap

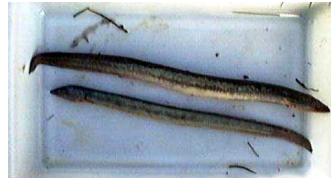
Length distribution Bois Jolis



Length distribution of eels caught in the by-pass

3. Mortality

1. The immediate mortality rate is 10.9 % for silver eels.
2. Only one case of differed mortality was observed. Lesions are skin abrasion in regard with the configuration of the pipe. Mean term mortality (> 3 days) are unknown.
3. Before by-pass was modified, mortality would have been of 100%, its section being too small and the water speed impeaching U-turn of eels.
4. There is no significant difference of mortality according to the length (sample too small), but the mortality's rate is 26 % for eels over 500 mm length and only 8.5 for smaller eels.



4. Efficiency

The study on Pont es Omnes station allowed to estimate the annual transit of eels in 1998 between 800 and 850 eels (A. ACOU in prep). The efficiency of the by pass is about 12 %.

If we consider that transit is proportional to flow, the number of eels passing over the crest could be estimated.

Périod	Number of eels in the By -Pass	Number of eels estimated on the crest	Total
1/10/98 - 14/12/98	82	8	82
15/12/98 - 15/01/99	49	774	823
Total	131	774	875

This new estimation is compatible with the other estimation. In this case the water flow seems to be a main factor of efficiency for by-pass systems.

5. Migration delay

8 eels were recaptured at Pont es Omnes trap. They arrive in 4 days during the migration peak. They wait the increase of the flow in Pont es Omnes pond to go off again.

If the by pass permit to eels to pass over the first dam, after they stop their migration and seem to wait a new starting factor to go again.

N°	Releasing date	Arrival at Pont es Omnes trap	Duration No. days
1	22/10/98	17/12/98	56
2	27/10/98	16/12/98	50
3	27/10/98	17/12/98	51
4	27/10/98	16/12/98	50
5	30/10/98	16/12/98	47
6	30/10/98	17/12/98	48
7	30/10/98	17/12/98	48
8	21/12/98	20/12/98	18

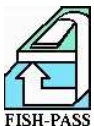
Catches of marked eels at Pont es omnes station

CONCLUSION

Eels seem to use the different possibilities to pass over a dam, in particular they can use pipes with small flow, but their design needs to be adapted to reduce mortality.

By-pass systems could be used to increase the escapement of silver eels. In a first step, Eel's transit seems to be proportional to the water discharge. Efficiency of by pass systems would be increased by a specific management of the water discharge and (or) with deflecting systems.

By-pass systems do not resolve the delay in downstream migration. After their passage, eels seem to stop their migration and wait for a new departure.



ACKNOWLEDGMENTS

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