Investigation of failure of migrating juveniles to cross Tewkesbury weir

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Juvenile eels (Anguilla Anguilla) were observed ascending the weir at Tewkesbury on the River Severn. A closer investigation of the movement of these juveniles revealed that the migration was largely unsuccessful due a number of obstacles. While the primary cause was identified as the narrow water/land interface there were other secondary obstructions involving steep gradients and high water velocities that would have also prevented the ascent. Some recommendations were made as to how the water flow could be reduced to improve the ascent.

Introduction

The river Severn basin has a wetted area of 21590km². There are weirs in the lower Severn at Gloucester (Llanthony, Maisemore) and Tewkesbury to maintain water levels for navigation. At particular states of the tide and water levels these weirs are a significant barrier to the upstream migration of glass eels and juvenile eels. The loss of migratory pathways is one of the causal factors that has been attributed to the decline in eel populations.

Glass eels are not capable of a sustained active migration and they must metamorphose into small eels, (attaining a weight of at least 0.5 gm) before they are able to undertake a secondary active migration later in the summer. This migration coincides with increased water flows and it may be synchronous involving many thou- sands of small eels.

The weir is approximately 1.5 metres in height with a fish pass cut into the top of the weir on the right hand side creating a very strong flow of water across the face of the weir. At the base of the weir there is a gently sloping surface where a wide shallow slow moving wet interface exists between the bank and the rapid spillway.

Moving towards the crest of the weir this interface becomes steeper and narrower and offers little protection from the rapidly flowing spillway. Some 7 meters from the top of the weir this interface it is obstructed by a clay land drain forming a vertical surface with no interface.

At the time the migration was observed river flows were such that an additional obstruction in the form of a small standing wave was created opposite the drainage

pipe. Between this drain and the crest of the weir the gradients on the side of the weir are much steeper. The interface is very much narrower, the surface is damp but free of water.

At the crest there is no interface just a very rapid stream of water over a distance of approximately 0.3 M.

Observations

On the 25 July 2010 after a small increase in river flow juveniles ranging in size from 0.5 to 10.0 gm were observed ascending the side of the weir. The large discharge volume over the fish pass had attracted thousands of juvenile eels just below the spillway. From this point these juvenile eels following the wide interface at the base of the weir actively migrated up the interface for several meters. However as the interface became narrower and steeper these juveniles lost their adhesion to the substrate well before reaching the first major physical obstruction at the land drain.

The rapid current swept the juveniles back down the spillway. There were also clumps of passive juveniles (presumably too exhausted to move) resting on the weir and in the deep water just below the weir.

A small number were able to continue but the evidence would suggest that the gradient selected juvenile eels of less than 2 gm.

These juveniles were seen within 0.5 metres of the crest of the weir though none were actually observed crossing the crest.

Red Arrow.
Marks approximate limit of competent ascent

Discussion

The Tewkesbury weir defines the upper tidal limit of the river. Only the largest of the spring tides can flow across the weir. During the juvenile migration period in the summer there would be some 15-25 tides that would level or flow the weir. Appendix 1. Juvenile eels must be able to traverse this barrier if they are to access the middle, upper Severn and the Avon system. While the weir is passable in flood conditions and some spring tides it is unlikely that these conditions will coincide with the active synchronous migration of juvenile eels. The synchronous migration is probably associated with increased summer flows. Appendix II.

The narrow migratory interface, the steep gradients and rapid water velocities make the weir impassable to the majority of the juvenile eel population. The conditions select the passage of juveniles less than 2 gm. The construction of permanent passes that are resilient and maintenance free is a particularly demanding engineering task. Perhaps alternatives should be examined e.g. specialised lower cost temporary structures that facilitate the passage of eels at designated times of the year.

An immediate and low cost solution to the problem would be to temporarily reduce the flow of the water over the weir by strategically placing one of two 500 kg bags of sand on the crest of the weir. These bags would be placed on the weir at the start of each summer.

It is likely that the reduction in gradients on the weir and increasing the width of the slow moving water face interface with some overhead protection to reduce the risk of desiccation and attack from predators would also be beneficial.

A monitoring program needs to be introduced to gain a better understanding of juvenile movements over these fixed structures.

A high-performance Y-cam IP camera that operates independently, without the need to be connected to a computer, in full colour with infrared night vision and micro SD recording might be a low cost recording solution.

Appendix I

2010 Predicted Tides Sharpness 9.5 +/- 0.5 metres likely to level and/or overflow Tewkesbury Weir.
Tide will level and/or overflow for 30-45 minutes only
Tidal impact highly dependant on local river conditions.

Month	Date	Tide (m)	Flood weir
Apr	1	9.8	Yes
		9.5	Yes
	2	9.2	?
	28	9.1	?
		9.2	?
	29	9.1	?
		9.1	?
Jul	12	-	No
		9	?
	13	-	No
		9.3	?
	14	9	?
		9.3	?
	15	9	?
		9.2	?

Month	Date	Tide (m)	Flood weir
Aug	10	-	No
		9.5	Yes
	11	9.3	?
		9.9	Yes
	12	9.7	Yes
		10	Yes
	13	9.6	Yes
		9.8	Yes
	14	9.2	?
		9.1	?
Sep	7	-	No
		9.1	?
	8	9.2	?
		9.9	Yes
	9	9.8	Yes
		10.2	Yes
	10	10	Yes
		10.2	Yes
	11	9.8	Yes
		9.8	Yes
	12	9.2	?
		9	?

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Appendix II