THE EFFECTS OF A BARRAGE ON THE MIGRATION OF ATLANTIC SALMON (*Salmo salar* L.) SMOLTS AND ADULTS

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Introduction

In recent years there has been increasing interest in the UK in the construction of estuarine barrages for urban regeneration, hydroelectric power generation and flood defence purposes. There is concern as to the possible effects an estuarine barrage may have on diadromous fish species that move between freshwater and marine environments. Behavioural studies on the impact of such a barrage on Atlantic salmon were carried out on the River Tawe in south Wales between 1993 and 1995.

Barrage construction across an estuary results in:

- A modified tidal cycle upstream of the barrage
- Significantly reduced ebb and flood tidal cues and currents used by salmonids to orient themselves
- Creation of a large lagoon upstream of the barrage
- Reduced saline intrusion and 'flushing'
- Poor water quality above the barrage (pH, BOD, temperature, contaminants, etc.)
- A partial physical barrier to migration

River Tawe Barrage

Primary and secondary weirs

Low tide

'Pool and traverse' fish pass

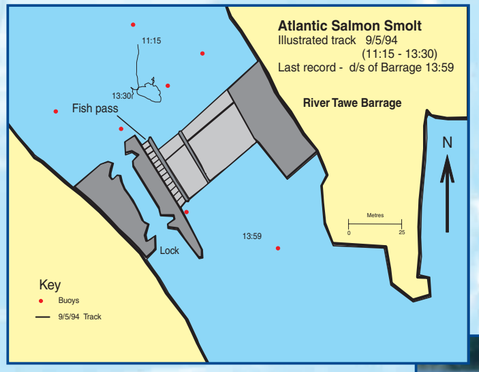
Over-topping high tide

Smolt migration in unmodified river estuaries

- Movement is indicative of a nocturnal selective ebb tide transport pattern of migration
- Movement involves passive seawards migration in the upper water column
- Fish orient themselves to remain within the maximum ebb tide currents
- Migration in the lower estuary and coastal waters switches to active swimming, often against the prevailing currents
- Relatively rapid movement occurs under the cover of darkness
- Migration into the marine environment occurs during a narrow 'window of opportunity'

Smolt migration in modified river estuaries

- Fish exhibit increased residency within the lagoon (2-20 days)
- Undirected movements and exploratory behaviour predominate in the impoundment
- Increased exposure to avian predators during daylight hours occurs within the impoundment
- Difficulty in negotiating the barrage is apparent
- Late entry into the marine environment is probable



Cormorants

Adult migration in unmodified river estuaries

In the lower estuary:

- Largely passive tidally directed movements occur
- Residency varies from one tidal cycle to many weeks
- Fish may hold station at suitable locations in the estuary
- There is little effect on movement from fluctuations in river flow

In the upper estuary:

- Active movement against the prevailing flow occurs
- Movement is largely independent of the tidal cycle
- Movement is related to river flow

Adult migration in modified river estuaries

- The majority of fish hold station below the barrage for extended periods
- Many fish hold station in or near the plume from the fish pass
- Increased exposure to seal predation occurs below the barrage
- Migration across the barrage occurs during over-topping tides
- The fish pass is infrequently used
- Largely random movements occur in the impoundment above the barrage

Grey seals
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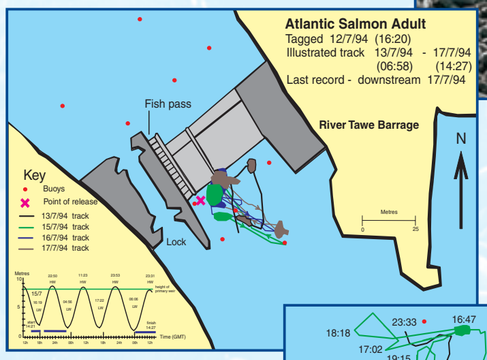

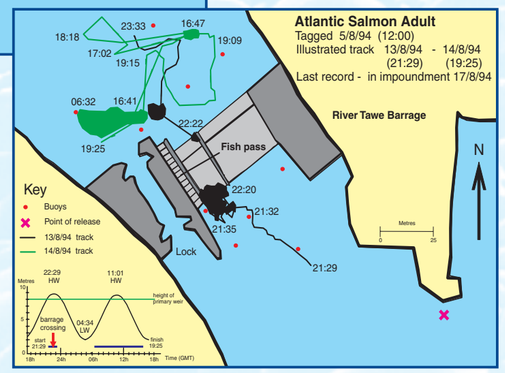

Conclusions

- The fish pass incorporated into the barrage was infrequently used
- The barrage can act as a physical barrier to the movement of adults and smolts through an estuary and expose them for long periods to increased predation pressure
- The barrage restricts passive tidal transport of adults and smolts
- Both adults and smolts can be subjected to increased residency times in the upper estuary, which exposes them to increased levels of contaminants that accumulate in the impoundment
- The barrage reduces or removes flow related cues used by adult Atlantic salmon
- Adults and smolts may be subjected to increased physiological stress when residing within the impoundment. In smolts this may reduce marine survival, and in adults this may reduce their fitness to spawn

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