DAMS, POLLUTION AND OTHER IMPEDIMENTS TO MIGRATION AND SPAWNING

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Contents

Summary

Most fish species must change habitats to reproduce, and man’s impediments to this strategy (e.g. dams and other forms of water flow management) may have a deleterious effect on fish population dynamics and conservation. The quantity and quality of the physical habitat available for spawning has also undergone strong modifications (through flow regulation, channelization, land-use, etc.) and these changes have affected fish spawning behavior and success. Impediment management must focus on the means to improve spawning habitat quality. In many areas this could be accomplished through restoration of flow heterogeneity (spatial and temporal). Efforts must also be taken to

re-establish the connectivity between growth habitats and spawning habitats with a special awareness of the outstanding importance of temporal factors.

1. Introduction

The "world of water," including open oceans, coastal areas, and inland lakes and waterways, is heavily exploited and harvested by man. Most aspects related to Marine Ecosystems have been addressed by others' contributions in the EOLSS Theme entitled "Fisheries and Aquaculture: Fish and Other Marine and Freshwater Products". Thus, this article will deal exclusively with the Freshwater Ecosystem. Freshwater is used for human and animal consumption, irrigation, industry, energy production, and recreation. Sediments are dredged for construction. It has recently been estimated that dams have fragmented almost 60% of the world's rivers. In addition, many recent catchment studies have revealed the influences of terrestrial ecosystems on water chemistry and stream biota. These multiple uses have numerous effects on aquatic ecosystems and the fishes that utilize them. Many fishes with high fishery value are diadromous and, as such, must travel throughout the "world of water" to reproduce at sea (catadromous species, e.g. eels) or in freshwater (anadromous species, e.g. salmon). However, holobiotic species also undergo spawning migrations since the environmental conditions of feeding habitats do not necessarily comply with incubation and rearing habitat conditions. Hence, at a given season (usually spring and early summer) many fish move into spawning areas. This usually implies lateral (often towards backwaters or seasonally flooded vegetation, e.g. carp, pike, perch) or longitudinal displacements (often towards tributaries, e.g. trout, grayling). Water quality experienced during maturation and spawning migrations, availability of spawning habitat and quality of connections (distance, presence of obstacles, etc.) between spawning and feeding habitats represent important environmental components for the maintenance of fish populations.

2. Impediments to Migration: River Obstacle Construction, Fishing, and Water Quality

2.1. Physical Obstacles

Bridges, sills, dams, etc. may cut off longitudinal connectivity needed by most fishes to carry out reproduction. The magnitude of an obstruction to migration not only depends upon the obstruction's height, but also upon the specific hydrodynamic conditions associated with the obstacle at the time of passing (e.g. velocities, water depths, turbulence) and upon the swim speed and endurance of the fish utilizing the waterway. Location of dams in the river course is also important: estuarine dams have catastrophic consequences for diadromous species because they usually prevent all fish passage, thus sterilizing the entire watercourse. Dam construction began about a thousand years ago, with most construction occurring during the last two centuries, mainly for inland navigation, flood and flow regulation, and energy production. Most big dams were constructed during the last century with more than 200 major dams completed between 1962 and 1968 in North America. Nowadays the proportion of flow stabilized by dams exceeds 20% in Africa and North America, 15% in Europe and Asia, and 5% in South America.

Because most dams represent an obstacle to migration, many have been equipped with passing devices of one sort or another, such as fish ladders, Denil passes, fish elevators, etc. (see Figure 1) and with behavioral (light, sound, electricity) or mechanical screens to prevent entry into turbine draft-tubes (see Figures 2 and 3). A major problem is that efficiency of fish passing varies with river flow, which affects both the attractivity and the passability of the obstacle. While fish-passing technology has proven efficient for salmonids moving upstream, most devices cannot be negotiated by other anadromous species such as shad or sturgeons. The valuable Acipenseridae have been particularly threatened by hydroelectric obstacles in most of their distribution areas. In addition, fish may lose time waiting for favorable flow and/or temperature conditions before passing. When obstacles are numerous, delays may decrease the physical conditions of fish and impact spawning success because fish may spawn in unfavorable areas or because ovocytes may over-mature.

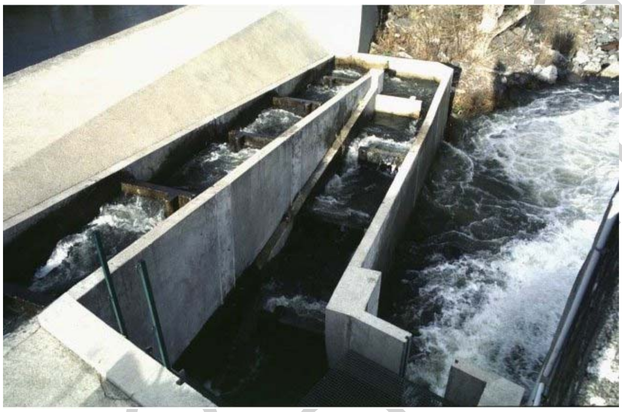

Figure 1. An example of a fish pass (successive pools), EDF hydro-electric power plant (Loire River, Brives-Charensac, France). *(Photo: H. Carmié – Photothèque CSP).*

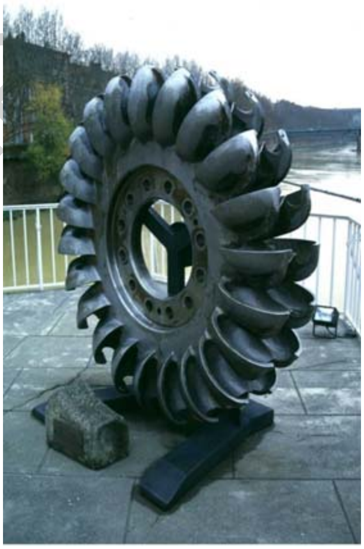

Figure 2. Turbine, Pelton Wheel, Bazacle hydro-electric power plant (Toulouse, France).
(Photo: J-M. Gougis – Photothèque CSP).

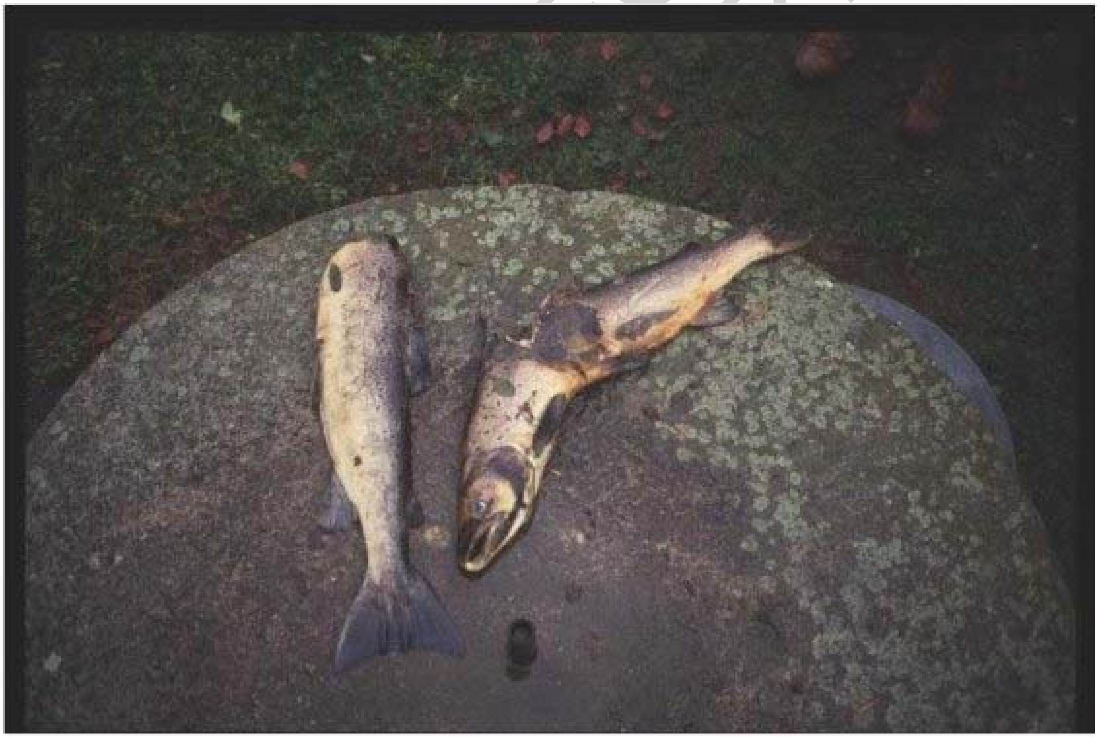

Figure 3. Trouts injured after passing through the turbines at the EDF power dam on the Allier River. *(Photo: H. Carmié – Photothèque CSP)*
a: Salmons injured after passing through the turbines at Langeac (Loire River). *(Photo: B.M.S. – Photothèque CSP)*
b: Eels injured after passing through turbines of an hydro electric power plant.

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Biographical Sketches

Agnès Bardonnet graduated from Lyon University, France, with PhD in Freshwater Ecology. After a post-doctorate in S.O.A.F.D. Freshwater Laboratory, Pitlochry, Scotland, UK, she entered the National Institute for Agronomical Research (INRA), in the Department of Hydobiology and Wildlife. Her research topics mainly focus on the behavioural ecology of amphibiotic fishes, with special concern to habitat conservation.

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