

## Restoration of longitudinal connectivity and salmonid habitat in River Mörrumsån (Sweden)

River Mörrumsån is located in southern Sweden, flowing into the Baltic Sea, and is one of the REFORM river restoration case-study sites. River Mörrumsån has an annual mean flow of 27 m<sup>3</sup>/s at the river mouth and a catchment area of 3369 km<sup>2</sup> (figure 1). The ecological status of the river is moderate in its lower reaches. This qualification results primarily from a lack of verified reproduction of the freshwater pearl mussel (*Margaritifera margaritifera*), since the parameters for nutrients and chemical status (excluding Hg) are good.



**Figure 1.** Location of the restored site at Hemsjö in River Mörrumsån in southern Sweden.

The river has long been an important reproduction site for Baltic salmon and sea trout. The main bulk of Baltic salmon migrates to the Gulf of Bothnia and into the large rivers of northern Sweden

(and to a lesser extent to northern Finland) to spawn. However, nearly 50% of the total smolt production of the sub-population of Baltic salmon that spawn in rivers flowing directly into the Southern Baltic is believed to originate in River Mörrumsån. It is probably the best-known salmon-bearing river in Sweden and sports fishing for salmon and sea trout in the Mörrumsån is internationally renowned.

At the same time, the Mörrumsån has been substantially exploited for hydropower production similar many Swedish rivers. This started in the late 19<sup>th</sup> century and continues to this day, creating numerous migration barriers and greatly reducing the reproduction area available for spawning runs of migrating anadromous salmonid fish. In 1945 the hydropower dam in River Mörrumsån located nearest to the sea (Marieberg hydropower

plant) was equipped with a functioning fish ladder. Since then, the lowermost of the two hydropower plants located upstream from Marieberg, at Hemsjö (Hemsjö nedre hydropower plant), became the first definite barrier for fish migrating from the sea. The Hemsjö nedre hydropower plant is located ca. 20 km from the river mouth. In the old water rights agreement no minimum flow was set for the natural channel connecting the two hydropower stations at Hemsjö, meaning that the river section could run completely dry at times.

## Restoration measures

In the early 1990s the Swedish board of fisheries raised the issue that longitudinal connectivity should be restored at Hemsjö to increase the available spawning area for Baltic salmon and sea trout in the river. After negotiations, predominantly outside of court, with the energy company owning the hydropower stations at Hemsjö and the legal right to utilize this river stretch for hydropower production (E.ON), an interest group (The River Mörrumsån Fish Conservation group) was created with the joint goal to protect and promote the salmonid fish population in River Mörrumsån. E.ON was a partner of this group together with the Swedish Agency for Marine and Water Management (formerly the Swedish board of fisheries) and several other Swedish government agencies and private corporations. After years of planning, testing and evaluating different restoration strategies, the construction of two fishways (nature-like partial width rock ramps) at Hemsjö nedre and Hemsjö övre hydropower stations started in 2003 (figure 2). A new water rights agreement was also established for Marieberg, Hemsjö nedre and Hemsjö övre hydropower stations. Among other provisions, the agreement stipulated that:

- A minimum flow of 0.5, 1 or 3 m<sup>3</sup>/s (depending on the season) should be directed through the fishways at Hemsjö övre and Hemsjö nedre hydropower dams and through the natural channel.
- For five weeks in the spring, when the smolt migrate to the sea, hydropower generation should be reduced to half the available potential or ceased completely at the three hydropower stations.

The cost for these restoration measures and the reduction of hydropower output in the affected stations was shared by the partners of the interest group. The River Mörrumsån Fish Conservation group has remained active after the initial restoration measures. This has facilitated e.g. the installation of automatic fish counters at the Marieberg and Hemsjö övre fishways as well as the addition of hundreds of cubic meters of salmonid spawning gravel to areas in the former dry channel between Hemsjö nedre and Hemsjö övre and to other stretches of the river in 2004, 2005, 2006, 2010 and 2012 (figures 3 and 4).



**Figure 2.** Nature-like partial width rock ramp constructed at Hemsjö nedre hydropower dam in River Mörrumsån in 2003-2004. Photo by Frauke Ecke, SLU.



**Figure 3 + Figure 4:** Overview of parts of the restored stretch in River Mörrumsån (left), also visible is the man-made channel feeding the Hemsjö övre hydropower station. To the right a photo of a restored stretch during a flow episode when more than the dictated minimum flow of 1 m<sup>3</sup>/s has been directed through the natural channel. Salmonid spawning gravel was added here in 2010. Photos by Frauke Ecke, SLU.

### Restoration success

Results from the automatic fish counters at Marieberg and Hemsjö övre fishways have revealed that on average about 50% of the spawning migrating salmonid fish that pass through the fishway at Marieberg hydropower dam continue upstream through the fishways at Hemsjö nedre and Hemsjö övre hydropower dams. On average ca. 550 salmonid fish (293-954) are recorded in the fish counter at Hemsjö övre each year (2007-2013). The creation of new migration routes at Hemsjö nedre and Hemsjö övre hydropower stations has opened up an additional 10 km of the river and increased the area available for salmonid reproduction with about 20 ha (equivalent to ca 50% of the total available habitat). Spawning salmonid fish have been observed on almost all of the gravel beds that were created in the former dry channel between the hydropower stations and upstream of Hemsjö after the restorations. Young salmon and trout have been caught by electrofishing (total 21 samplings in 2010-2012), sometimes in very high densities (>2 individuals/m<sup>2</sup>).

Field sampling was carried out in a subsection of the restored stretch between Hemsjö nedre and Hemsjö övre as part of WP4 of REFORM. Results showed that several organism groups displayed a greater diversity in the restored stretch compared to a non-restored similar river stretch located further upstream, e.g. fish, macrophytes and benthic invertebrates.

The restoration has also been hailed in Sweden as an example of successful cooperation between private stakeholders and government agencies, or financial interests vs. environmental concerns, in ecological restoration.

### **Cited literature and further information:**

D4.3 Results of the hydromorphological and ecological survey

Mörrums kronolaxfiske

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