

## Hydropower and hydromorphological impacts in freshwater pearl mussel (*Margaritifera margaritifera*) rivers: ecological bottlenecks and potential mitigation measures

Marie-Pierre Gosselin<sup>1</sup>, Jo H. Halleraker<sup>2,3</sup>, Bjørn Mejdell Larsen<sup>1</sup> Knut Alfredsen<sup>2</sup>.

<sup>1</sup> Norwegian Institute for Nature Research (NINA), Hogskolerigen 9, 7034 Trondheim, Norway

<sup>2</sup> Norwegian University of Science and Technology (NTNU), Department of Civil and Environmental Engineering, S.P. Andersens veg 5, 7491 Trondheim, Norway

<sup>3</sup> Norwegian Environment Agency, P.O.Box 5672 Torgarden, 7485 Trondheim, Norway

Email corresponding author: [marie-pierre.gosselin@nina.no](mailto:marie-pierre.gosselin@nina.no)

**ABSTRACT:** The freshwater pearl mussel (FPM) (*Margaritifera margaritifera*) is listed on the IUCN red list for endangered species as 'endangered'. Its populations have been declining throughout its range due to human pressures on river ecosystems. Under the EU's Habitat Directive, the species is recognized as a priority, and listed as such in Annexes II and V. It is an umbrella species and an excellent bioindicator meaning that its conservation will benefit the biodiversity and health of the rivers it inhabits. FPM is also a real ecosystem service provider dependent on viable salmonid fish populations to fulfill its life cycle. Norway represents a stronghold for the species and about 25 % of the remaining populations in Europe are located there (Larsen 2018). However, a third of the historically known populations of FPM in Norway have disappeared and 75% of the remaining populations are today not viable (Larsen and Magerøy 2019). Norway is also Europe's largest hydropower producer and the 7<sup>th</sup> largest in the world. Out of the 419 rivers with FPM in Norway, more than 70 are impacted by hydropower. Hydropower affects FPM both directly through alteration of its habitat or that of physico-chemical properties in the river, and indirectly, through impacts on salmonid host fish populations. In many rivers, hydropower is one of several co-occurring factors that have cumulative impacts on ecosystem functioning. It is therefore often difficult to disentangle the specific effects of hydropower from other pressures. In the case of the FPM, this kind of analysis has rarely been carried out.

One of the most widely implemented measures to mitigate hydropower related alterations in Norway is the release of a fixed minimum flow, with possible differences between summer and winter. Although a lot of studies have focused on habitat modelling and the effects of minimum flows for fish, much less is known about flow- and related hydromorphological requirements of FPM. We therefore argue that the effectiveness of minimum flows or ecological flow needs to ensure viable FPM populations is unknown. Addressing this knowledge gap is critical for the protection of this long-lived species, even more so in the context of multiple pressures like climate change and increased demand for flexible hydropower production. Here we present the results of a meta-analysis carried out using publicly available data on i) FPM population status, ii) hydropower mitigation requirements (e.g. level of Eflow), and iii) water framework directive related data, to establish the role of hydropower and related existing mitigation measures in affecting the status of FPM populations in Norwegian rivers. This includes assessment of the relationship between the intensity of hydropower impacts and the status of freshwater pearl mussel populations, as well as identifying ecological bottlenecks, possible suitable mitigation and management measures specially targeted for this species.