Sustaining hydropower production and salmonid populations: Ecological models for assessing hydropeaking and habitat restoration scenarios

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ABSTRACT: Hydropower is an important source of clean and renewable energy, but damming rivers has also caused severe losses of freshwater biodiversity. Thus, there is a great need for new ecological modelling tools to protect freshwater biodiversity while continuing to provide streamflows that can produce clean energy. In this project, we developed an individual-based model (IBM) to understand the effects of hydropeaking on fish populations. We parameterized and applied inSTREAM (7.2-SD) for high-conservation value populations of endemic brown trout (Salmo trutta) and Atlantic salmon (Salmo salar) in River Gullspång, a key hydropower-producing river in Sweden, under various flow scenarios. We calibrated the model by comparing predicted versus observed growth of juvenile fish under the current hydropeaking regime. We then modelled growth, survival and distribution under flow scenarios with and without hydropeaking. We observed that hydropeaking generally produced modest negative effects on growth and survival of both species; survival was more affected than was growth; smaller fish were more affected than larger fish. Under hydropeaking, on-peak (high) flows provided less profitable feeding conditions (less growth) and modelled fish were subject to more predation (lower survival). Our model appears to capture ecologically-relevant behavioural patterns under hydropeaking, for example, habitat selection and activity (feeding vs. hiding) in response to rapid flow changes. Collecting robust field data for such multiple management scenarios, even if possible, would be time-consuming and costly. Our study demonstrates the potential of IBMs as powerful tools for testing research questions and assessing and prioritizing alternative management strategies in regulated rivers.

Keywords: growth, hydropeaking, individual-based modelling, salmonid, survival