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Environmental flows

Ulla-Førre Hydropower Complex, Norway

Significant research effort to improve the hydrological regime in the Suldalslågen River, Norway, encourages salmon reproduction whilst providing increased hydropower generation capacity.

Overview

The River Suldalslågen is situated in Rogaland, south-western Norway. At the headwaters, Suldalsvatn Reservoir is 22 km long and has a 68 m head before its confluence with the Sandsfjord. The catchment area is affected by two regulation schemes; the Røldal-Suldal, initiated in 1967 (operated by Hydro), and the Ulla-Førre initiated in 1980 (operated by Statkraft).

Ulla-Førre is Norway's largest hydropower complex, with a total capacity of 2057 MW and an annual mean production of 4.5 TWh. The main power station, Kvilldal, with a capacity of 1240 MW, is Norway's largest power station. The main intake for the complex is 600 m ASL, and captures inflow from 39 rivers and brooks. Storage capacity is limited and water is pumped through the combined pump and power station of Saurdal to the main storage in the Blåsjø reservoir. Blåsjø is an artificial lake at 1000 m ASL, established by damming a number of small lakes. From the Blåsjø reservoir the water is utilized first in the Saurdal power station, then in Kvilldal power station and finally into Lake Suldalsvatn and the associated Hylen Power Station.

The Suldalslågen River has the largest natural water flow in the region, with unregulated flow averaging 91 m3/sec. During flood episodes, flow rates can reach 700 m3/sec through periods of reduced flow can be as little as 5 m^3/sec. Mean precipitation is 2000 mm/year.

Dam name

Scheme operator
Statkraft SF

Size of scheme (MW)
2057

Country
Norway

Catchment area

River
Suldalslågen

Effective reservoir capacity
unknown

Construction years
1980-present

Reservoir size
14.8 x 10^6 m^3

External recognition
Nil

Details

Atlantic salmon (Salmo salar) populations have been an important consideration for hydropower producers on the River Suldalslågen, the species occurring naturally and being farmed commercially along the river, along with brown trout (Salmo trutta). Flow regulation is thought to have been partially to blame for a perceived decline in Atlantic salmon populations, although data based on recreational salmon catch statistics do not support this observation.

Regulatory requirements for the Ulla-Førre Scheme specify minimum flow of 12 m^3/sec at a measuring point located near sea level during winter and 51 m3/sec in summer, the highest regulated minimum flow in Norway.

During the fishing season, 50 million m^3 were available to the owners of fishing rights for the initiation of migration-inducing flood events. These regulations proved to be inadequate in safeguarding the Atlantic salmon as the flow regime had no restrictions on ramp-down rates out of Lake Suldalsvatn, hence rapid water level falls caused mass stranding of fish.

In cooperation with local interest groups, environmental authorities, water resources administration and research institutions, trials of different flow regimes to minimise impacts on the Atlantic salmon fishery commenced in 1990. The ramp-down regime developed through this process restricted the flow reduction to 3% per hour.

Further river regulations were applied in 1998, including a requirement for comprehensive research into optimum operating regimes for mitigating flow-related impacts on Atlantic salmon. Two different hydrological regimes were tested during this period to determine which one best balanced hydropower and ecological benefits.

Natural variability within the salmon lifecycle has made comprehensive assessment of the outcomes difficult. However, the following effects of the new regulations have been observed:
• Restrictions of the rate of flow reduction have eliminated fish stranding events;
• Reduced flow in spring and summer has increased water temperature, with consequent increased growth rates of juvenile salmon;
• Flushing floods have proved efficient at maintaining channel stability and form; and,
• Short periods of flow at 200 m^3/sec appear to provide similar benefits to one week of floods at 150 m^3/sec, but use less water.

Preliminary conclusions have also been drawn concerning fish migration:
• Fluctuations in summer flows appear to increase migration of mature salmon to the river; and,
• Smolt migration seems to be initiated by an increase in water flow, rather than large flood events.

The final conclusions will form the basis for hydrological regimes in updated water management regulations.

Other Aspects

Passage of aquatic species
Atlantic salmon is an anadromous fish species, therefore the maintenance of seasonal flow regimes ensures that upstream migration is stimulated at the correct time of year for spawning.

Community engagement and acceptance
The derivation of water management regulations that minimise or eliminate impacts on the Atlantic salmon fishery, whilst maintaining adequate hydro-power production, required a collaborative effort between the scheme proponents, recreational users, fisheries managers and water management regulators. This collaboration has included a significant research component.

Further information

Source: Hydropower Good Practices Workshop, Annex VIII - Examples for Good Practice Report, Villach, Austria, October 2005. International Energy Agency.

http://www.statkraft.com/

Kaasa, H. 1998. Lakseforsterkningsprosjektet i Suldalslågen, fase II. Sluttrapport 1990-1997. Resultater og konklusjoner. Statkraft Engineering. Includes 180 detailed references.

Kaasa, H. 1999. Enhancement of an Atlantic salmon population. Recommended measures and their estimated costs. River Suldalslågen, Norway. International workshop on sustainable riverine fish habitat. Victoria, British Colombia 1999.