

Liming of salmon rivers in Norway; success depends on sophisticated strategy and organisation.



Directorate for
Nature Management

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INTRODUCTION

The rivers Mandalselva and Tovdalselva in southernmost Norway were formerly among the best Atlantic salmon rivers in the country. However, in the 1960s acidification wiped out the salmon populations of both rivers. Liming programmes in these two rivers began in 1996-97 with the aim of improving water quality to a level that would allow Atlantic salmon to reproduce successfully. The two rivers are quite similar in size: their catchment areas are approximately 1800 km², with mean annual flows of 70-90 m³/sec. The geographical extent of both rivers involve several municipalities and counties.

Salmon, which is extremely sensitive to acid and aluminium-rich water, is the main target species for the mitigation projects. Climatic conditions in Norway typically produce rapid changes in water flow rates, which in turn affect the water chemistry. Thus, liming is a complex task in terms of achieving an optimized and stable water quality. A total of 21 salmon rivers are currently being limed in southern and south-western Norway.

LIMING STRATEGIES

The strategy for improving water quality involves continuous liming with 0-0.2 mm calcite powder from dispensers, controlled by water flow and down stream pH in a feed back system. In the rivers Mandalselva and Tovdalselva, a total of nine and six dispensers, respectively, have been installed. The annual consumption of limestone powder in these rivers ranged between 6000-12000 and 4000-9000 tonnes, respectively, depending on the prevailing water flow each year.

These dispensers should always give the correct dose, never become empty, and never stop working. This is necessary in order to avoid lethal or sub-lethal water quality for salmon on one hand, and to avoid waste of resources on the other hand. Liming aimed to create a pH of about 6.2-6.4 during the critical period for pre-smolt/smolts in spring (1 April to 31 May) and between 6.0-6.2 during the rest of the year.

Atlantic salmon are now reproducing naturally in all the limed rivers, and densities of salmon fry have increased significantly over years since the first treatment.

LIMING ORGANISATION

The Directorate for Nature Management is responsible for the Norwegian Liming Programme, and administers the contracts for transport, purchase of limestone powder and monitoring programmes to assess the effects of these mitigation activities, in cooperation with the County Governors.

The County Governor coordinates national and local liming activities. In both rivers, several municipalities are involved in planning and implementing the liming programmes. Cooperation is ensured through contracts between the County Governor and relevant municipalities and local organisations. These contracts establish the responsibilities at regional and local level, according to funding and management of the mitigation activities.

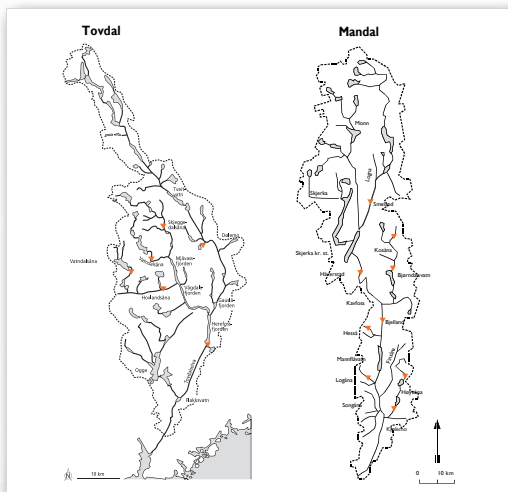


Figure 1. Outline of the catchment areas of the rivers Tovdalselva and Mandalselva, with locations of limestone dispensers.



Figure 2. The 21 limed rivers with Atlantic salmon in Norway.

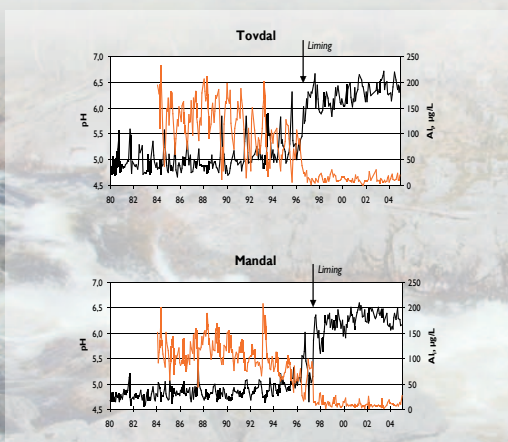


Figure 3. Before liming started, the pH in the rivers Tovdalselva and Mandalselva typically ranged between 4.6-5.5, as opposed to 6.0-6.5 after liming. Thus, the target water quality in terms of higher pH, and subsequent reduction in toxic aluminium during spring snow melt as well, is now largely being achieved in most limed rivers.

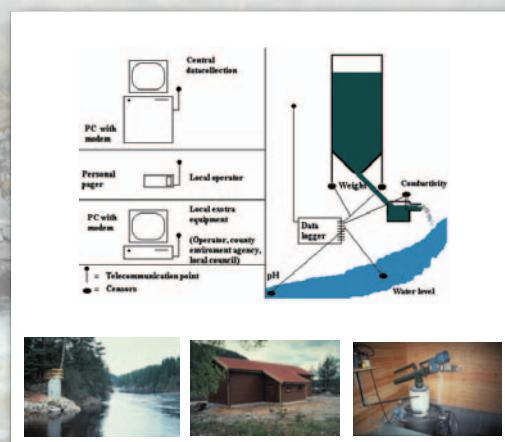


Figure 4. A typical lime dispenser, showing water inlet, building and water-lime mixing equipment. The diagram shows a specific dose-control system.

CONCLUSION

The liming strategy for the rivers Mandalselva and Tovdalselva demands an effective adjustment of dose according to water flow and water quality (pH). This gives a water quality which ensures healthy salmon stocks. The success of the liming programmes has been achieved through cooperation between local organisations, municipalities and the environmental administration in each county and at a national level.