The effects of liming on the freshwater pearl mussel (*Margaritifera margaritifera*) in a Norwegian river

BJØRN MEJDELL LARSEN & RANDI SAKSGÅRD; E-post: (bjorn.larsen@nina.no)
Norwegian Institute for Nature Research (NINA), NO-7485 Trondheim, Norway

INTRODUCTION

The freshwater pearl mussel (*Margaritifera margaritifera*) is threatened throughout its range, and is the subject of recovery programmes in many countries (cf. Degerman et al. 2009). The main reasons for the decline are anthropogenic influences on aquatic systems. During its life cycle the freshwater pearl mussel is dependent on the presence of salmonids as hosts for its larvae. Freshwater acidification has eliminated or reduced populations of Atlantic salmon (*Salmo salar*) in more than 50 rivers in southern and south-western Norway, along them the River Ogna in the south-west of the country. In 1982-1990, periodical fish mortality was observed in this river, and the freshwater pearl mussel population fell to a low level.

CONCLUSION

There have been positive trends in water chemistry indicators and in stocks of fish and freshwater pearl mussels in the first years of liming. The survey indicated that mussel populations have the potential for recovery when the conditions improve. However, the river is still sensitive to acid water and continues to be dependent on a steady supply of lime. To create a favourable environment for mussels, pH should be at least 6.2 all year round, and the content of calcium should be raised to 2.5 mg/l (cf. Larsen 2011).

STUDY AREA

The catchment area of River Ogna is 115 km² (**Figure 1**). The area consists mainly of slowly weathering rocks. The width of the river is 15 - 30 m, and the average discharge at the river mouth is 6.6 $m^3 s^{-1}$. The three main species of fish in the river are Atlantic salmon, brown trout (*Salmo trutta*) and European eel (*Anguilla anguilla*).

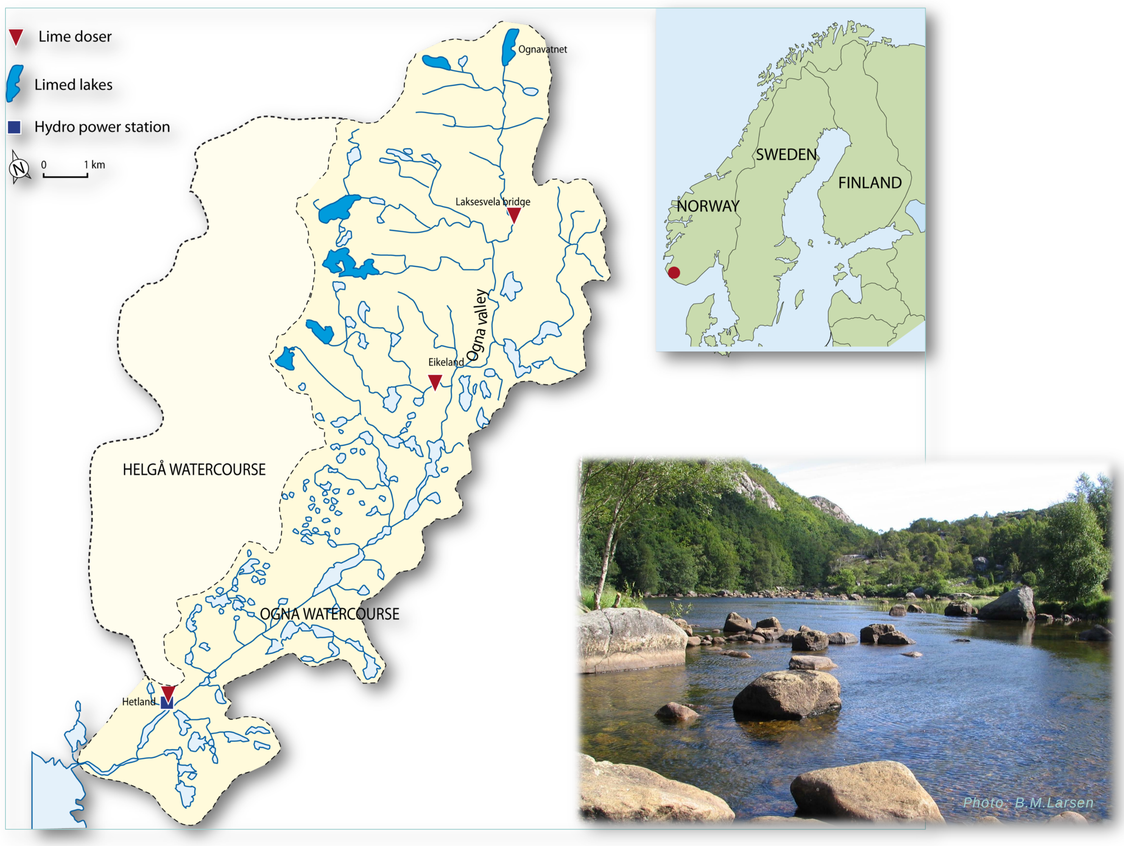

***Figure 1**. Location of River Ogna showing the catchment area with the lime dosers and limed lakes.*

LIMING PROJECT

The River Ogna sustained a low level of recruitment of salmon throughout the 1980s. In this period the mean annual pH was 5.2-5.8 (**Figure 2**). In an attempt to restore the Atlantic salmon population in River Ogna, a liming project was initiated in 1991. The river was limed with two main lime dosers and several of the larger lakes within the catchment were also limed (cf. **Figure 1**). Liming produced a gradual increase in the mean annual pH level to 6.6 in the late 1990s. An increase in calcium content was also evident in the first years after liming, and the annual average exceeded 2.2 mg/l (**Figure 2**). From 1994 there was a notable increase in the density of salmon fry from <20 to 60 - 90 individuals per 100 m². This resulted simultaneously in an increase in the density of older salmon parr. The effects of liming on the freshwater pearl mussel were assessed every third year from 1999 to 2008.

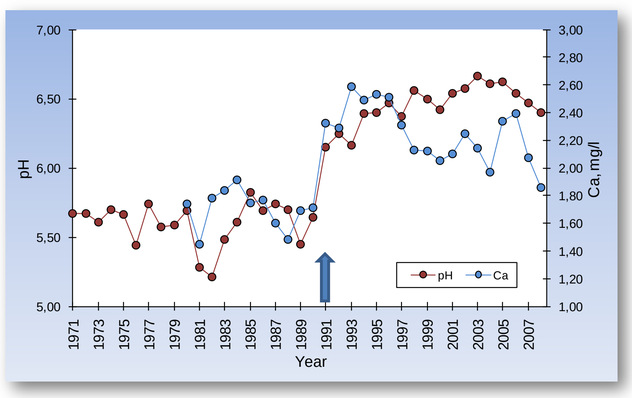

***Figure 2**. pH and calcium (Ca, mg/l) in River Ogna in 1971 - 2008. Data from the monitoring programme measured above Hetland power station (cf. Saksgård & Schartau 2009). Permanent liming was started in 1991 (marked with the arrow).*

FRESHWATER PEARL MUSSEL

Recruitment to the freshwater pearl mussel population was completely absent for many years, resulting in a predominance of older individuals (length 110 – 135 mm) in the 1980s. However, mature specimens were present, and their glochidia survived, attaching themselves to the gills of the Atlantic salmon host fish.

Finds of a few young mussels in 1999 indicated that recruitment was recovering from 1991 (**Figure 3A**). In 2002, the proportion of visible young mussels increased to 36% (**Figure 3B**) dominated by mussels of the year classes 1991 - 1998. In 2005 and 2008 about two thirds of the mussels were found to be younger than 15 and 18 years respectively.

The recruitment seems however, to have failed again by the end of the 1990s, and no mussels less than 30 mm (6 years old) and 50 mm (9 years old) were found in 2005 and 2008, respectively (cf. **Figure 3C** and **3D**). This can be caused by instability in water quality, re-acidification, expressed as a decrease in calcium content (cf. **Figure 2**).

The range of the freshwater pearl mussel has expanded from 4.0 to 4.8 km of the river. In 2008, young mussels were found at ten of twelve study sites, and mussel density has risen by more than 100% from 1999 to 2008 (cf. **Figure 4**).

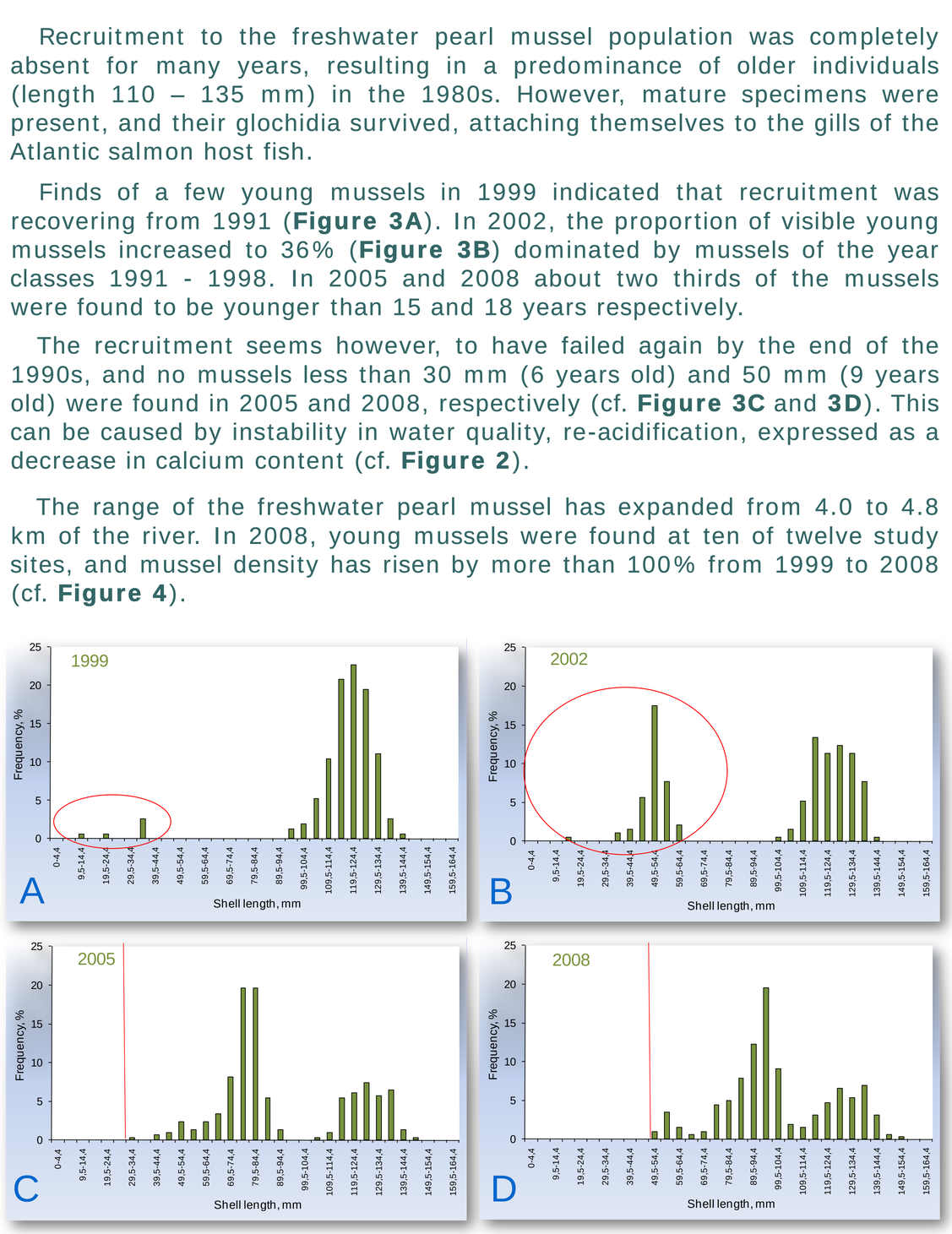

***Figure 3**. Length frequency diagram of living freshwater pearl mussels in River Ogna in **A.** 1999 (N = 154), **B.** 2002 (N = 194), **C.** 2005 (N = 295), and **D.** 2008 (N = 318).*

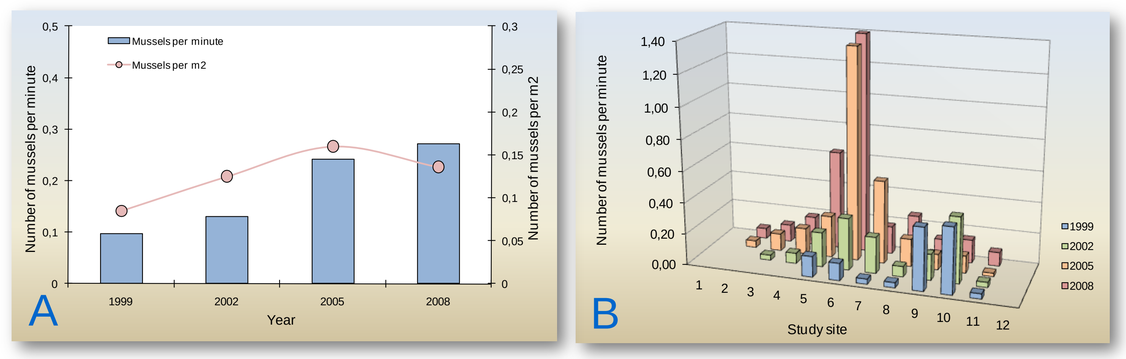

***Figure 4**. Density of freshwater pearl mussel in River Ogna. **A.** Mean annual density based on time-restricted counts (given as number of mussels per minute) and transects (given as number of mussels per m²) in 1999 – 2008. **B.** Density based on time-restricted counts on each of the study sites in 1999 - 2008.*

ACKNOWLEDGEMENTS

The monitoring programme on the freshwater pearl mussel in the River Ogna was financed by the Norwegian Directorate for Nature Management (DN).

REFERENCES

Degerman, E., Alexanderson, S., Bergengren, J., Henrikson, L., Johansson, B-E., Larsen, B.M. & Söderberg, H. 2009. Restoration of freshwater pearl mussel streams. - WWF Sweden, Solna. 62 pp.

Larsen, B.M. 2011. The effects of liming on the freshwater pearl mussel (*Margaritifera margaritifera*) in a Norwegian river. - In: Henrikson L., Arvidson, B. L. & Österling, M. (eds.). Proceedings of the International Conference on "Aquatic Conservation with Focus on the Freshwater Pearl Mussel *Margaritifera margaritifera*, Sundsvall, 12-14 August, 2009" - Karlstad University Studies, Sweden.

Saksgård, R. & Schartau, A.K.L. 2009. Ogna. 2 Vannkjemi. Kalking i vann og vassdrag. Effektkontroll av større prosjekter 2008. - DN-Notat 2009-3 [In Norwegian on www.dirnat.no].