

# The populations of the freshwater pearl mussel *Margaritifera margaritifera* in Natura 2000 site nature reserve “Melturu sils”

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## Abstract

The population of freshwater pearl mussel *Margaritifera margaritifera* in the river Pērļupe, known for pearl fishing till the beginning of the 20<sup>th</sup> century, was monitored during the period 1999 to 2010. The area is currently designated as a Natura 2000 site. Measurements of non-living shells showed that the proportion of small individuals in the population has been decreasing and that population ageing has occurred during the last years. Data on water quality indicated that the nitrogen and phosphorus concentrations are considerably higher compared to the optimum level. In addition, there are some problems with beaver dams and bad overall quality of the environment. The population will potentially recover if the river ecosystem improves.

**Key words:** age structure, Latvia, *Margaritifera margaritifera*, monitoring, non-living population, pearl mussel.

## Introduction

The freshwater pearl mussel *Margaritifera margaritifera* (Linnaeus, 1758) is an endangered species in its entire distribution area: most populations are declining, disappearing and are overaged. Only some populations in Europe, including in the Northern part of Russia, have a natural capability for recovery (Erikson et al. 1998; Araujo, Ramos 2000; Bepalaya et al. 2007; Makhrov et al. 2010; Jungbluth 2011). In Latvia almost the entire area of distribution has been monitored. These investigations showed that the remaining populations are extremely small and overaged (Rudzīte 2004; Rudzīte 2005).

One of the main reasons of extinction of freshwater pearl mussel in its distribution range is pearl fishing. The first known freshwater pearl mussel necklaces are from ancient Greece. Later, pearls were used in jewellery and in church ornaments (Bischoff et al. 1986). The main source of information about pearl fishing in the territory of Latvia is an article „Perlenfischerei in Liv- und Estland” written by prof. A. Meder in 1925. Information on Livland pearls is also found in „Versuch einer Naturgeschichte von Livland” written by J.B. Fisher (1791). However, besides fishing environment quality-related changes should be considered in explaining the decline of the pearl mussel population (Rudzīte 2004; Rudzīte 2005).

The nature reserve „Melturu sils” was established in 2004 and incorporated in the Natura 2000 network (code LV0527800), with the aim to protect the population of

*Margaritifera margaritifera* in the river Pērļupe. This species is included in the Bern Convention 1979, Appendix III and The EU Habitats Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, and in the Red Data Book of Latvia and protected species lists.

The aim of this study was to estimate the survival capabilities of the freshwater pearl mussel *Margaritifera margaritifera* population in the nature reserve „Melturu sils”. This has been previously estimated in the reserve using age structure of living individuals. The main objectives were (i) to determine the trends of the population during the last 30 years; (ii) to determine the age structure based on living individuals empty shells; (iii) to suggest explanations for the observed changes in freshwater pearl mussel living conditions. Empty shell material was used to estimate the previous (two to three years earlier) population age structure.

## Materials and methods

Natura 2000 site nature reserve “Melturu sils” (code LV0527800) is located on the Pērļupe river basin. The river is small, as almost all of the pearl rivers of Latvia (eight out of nine). It lies within the river Gauja basin. The river Pērļupe is a 2<sup>nd</sup>-step tributary of the river Gauja.

The river Pērļupe has been periodically surveyed from 1999 to 2010. The population size located in the territory of the nature reserve was determined in 1999 (Rudzīte 2001)

and 2003 (Rudzite 2004), and in 2008 as part of Natura 2000 monitoring and repeatedly in 2010. During the surveys the entire riverbed was visually inspected and all seen mussels were counted.

The data on pearl mussel numbers prior 1999 were obtained from unpublished data (Rudzite 2001).

The shell length was measured with ruler. The shell lengths were grouped in classes with steps of 5 mm. Length classes were considered to represent age classes. This method is widely used, as it allows to obtain data quickly and is mussel-friendly (Hruška 1992; Erikson et al. 1998; Heinisch et al. 2001; Rudzite 2001; Bepalaya et al. 2007). Also dead mussel shells were measured. In 1999 to 2001 all shells in the river, in different stages of weathering, were collected and measured. The total number of shells was 204, which were divided into two groups. The 1<sup>st</sup> group (150 shells) was comprised of old, badly weathered shells, including fragmented ones with large defects but with measurable length and definable species. The 2<sup>nd</sup> group (54 shells) included empty shells without marks of long-time weathering, probably from mussels that died during the last few years. In 2010, 142 empty shells were measured: 17 shells from the 1<sup>st</sup> group and 125 shells from the 2<sup>nd</sup> group. In addition, some very old, weathered fragments of shells were found, which could not be measured.

## Results and discussion

Previous studies have suggested that the population in Pērļupe was aged and declining (Rudzite 2001). Using the evaluation of populations worked out in Sweden, the population has low recruitment and poor chance of survival (Erikson et al. 1998; Rudzite 2005). The results obtained in surveys of 2008 and 2010 indicate that the decline is progressing. During the period 1977 to 2001, the population had decreased nearly four times, and during the last 33 years (1977–2010) by about 20-fold (Fig. 1).

In 2001 the age structure of population (Fig. 2A) indicated definite ageing. Comparison of the age structure for living animals with that estimated for empty shells – the non-living part of population – (Fig. 2B, C) indicates that gradual ageing of the population over several decades. The age structure obtained from the 1<sup>st</sup> group, composed of weathered shells (Fig. 2 B), indicated that the youngest classes, 50 to 70 mm and also 40 to 45 mm were present. Evidently, previously, maybe decades ago, the age structure of this population was nearly normal, with a sufficient proportion of young mussels. The results obtained for the 2<sup>nd</sup> group, composed of slightly weathered shells (Fig. 2B), suggest that the population had already ageing as there were no individuals smaller than 80 mm. Data from 2010 confirmed a similar age structure for the non-living part of the population. Shells of young mussels were found only among weathered, old shells (Fig. 3A, B, C),

The name Pērļupe means „river of pearls”, which

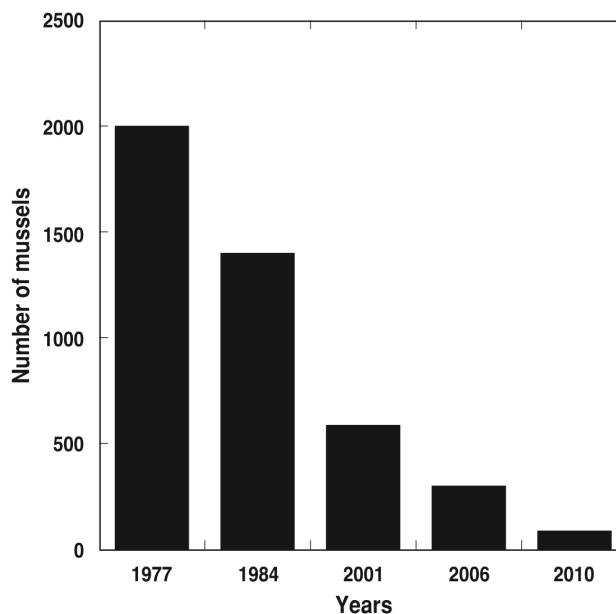
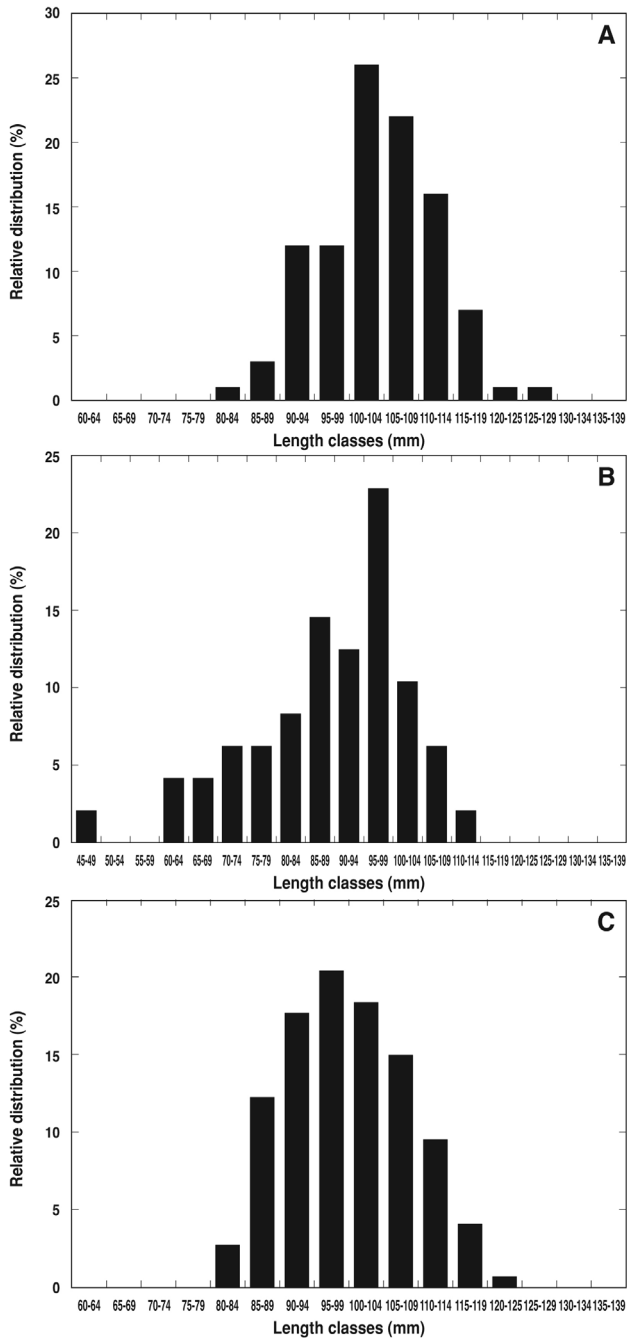


Fig. 1. The decline of population of freshwater pearl mussel in Pērļupe from 1977 till 2010. In 2010 the counting was not complete, and the actual number of mussels might be higher

suggests that pearls had been fished in this stream. One of the reasons for the population decline in Pērļupe was the massive pearl fishing that took place in the 17<sup>th</sup> and 18<sup>th</sup> centuries, as described for Līfland and rivers of the Gauja basin (Wahl 1855; Kawall 1872; Eke 1925; Meder 1925; Pētersons 1933; Schlesch 1942). Some articles in newspapers of 1937 indicate that pearl fishing occurred in Pērļupe even at that time (Rudzitis, Rudzite, unpublished data). Regarding the distribution of pearl mussel in Latvia, in the reports from the 19<sup>th</sup> and 20<sup>th</sup> century suggested that pearl mussel population had been overfished and its size had decreased drastically.

There are four small rivers named Pērļupe in Latvia. Only one of them has a living population of freshwater pearl mussels. In 1996, a survey of Pērļupe/Perlijogi on the Latvian/Estonian border showed that this river had a width only a few meters, and no pearl mussels were found. However, I. Valovirta, who surveyed this river in 2003 in Estonia, reported that pearl mussel still persists (I. Valovirta, personal communication). In 1999, a survey of the Gauja tributary Pērļupe showed that this river had been reconstructed into a drainage channel, in which there were several large beaver dams. In 2002 Pērļupe, a tributary of Svētupe, was observed to have been transformed into a cascade of fishing ponds, in which pearl mussel was not found (M. Rudzite, unpublished data).

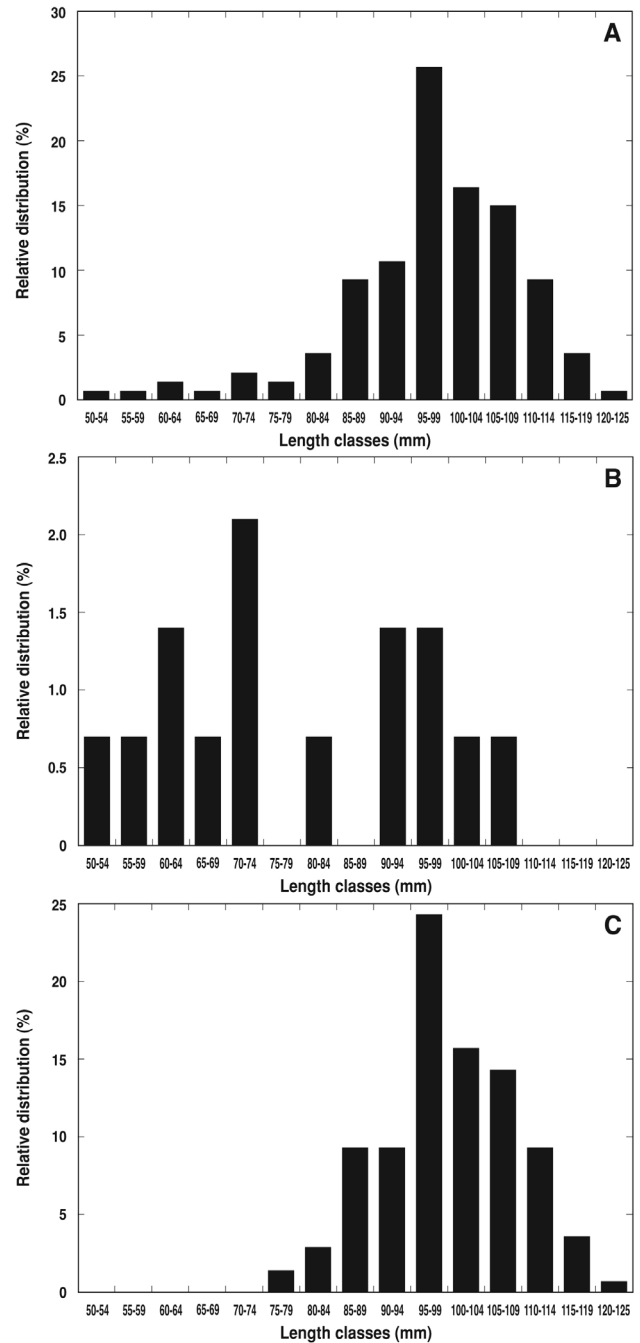
In 2001 water quality was determined in all the pearl mussel rivers of Latvia. This study showed that the living conditions were not suitable for pearl mussel (Rudzite 2004). Young pearl mussels are most sensitive to a high ammonia level (Buddensiek 2001). In the Pērļupe river the



**Fig. 2.** Population age structure (in length classes, mm) of *Margaritifera margaritifera* in Pērļupe river in 2001. A, living individuals, n = 146. B, non-living individuals, the 1<sup>st</sup> group (badly weathered shells), n = 54. C, non-living individuals, the 2<sup>nd</sup> group (slightly weathered shells from recently dead individuals), n = 150.

level of nitrogen and phosphorus was considerably higher than the optimum level (Table 1).

In 1999, and later in the nature reserve "Melturu sils", beaver dams were found in abundance (M. Rudzīte, unpublished data). Research in other pearl rivers in Latvia suggested that, in the zone of influence of beaver dams,



**Fig. 3.** The population age structure (in length classes, mm) of *Margaritifera margaritifera* in the Pērļupe river in 2010. A, non-living individuals, total, n = 142. B, non-living individuals, the 1<sup>st</sup> group (badly weathered shells), n = 15. C, non-living individuals, the 2<sup>nd</sup> group (slightly weathered shells from recently dead individuals), n = 127.

populations of pearl mussels are more overaged (Rudzīte 2005; Rudzīte, Znotiņa 2006). In 2005–2007, in the nature reserve, 20 beaver dams were destroyed and 11 beavers were culled with the help of a local hunter group. In 2007, the water courses had been restored (M. Rudzīte, unpublished data). Since 2009 beaver control is managed by the staff of

**Table 1.** Nitrogen and phosphorus concentrations in water of Pērļupe river. Data from the following sources were used. Ireland and Austria – Moorkens et al. 2000; Austria, river Waldaist (Scheder et al. 2011); Czech Republic, river Lužní Potok, a border stream with Bavaria (Bily et al. 2008); river Pērļupe 1984 (Latvian Regional Environmental Boards in Valmiera, A. Tukiša, unpublished data), Pērļupe 1993-1995 (Latvian Regional Environmental Boards in Valmiera, V. Bernards unpublished data), Pērļupe 2001 (Rudzite 2004)

Populations	Dissolved oxygen (% saturation)	Conductivity ( $\mu\text{S cm}^{-1}$ )	Oxidized nitrogen ( $\text{mg L}^{-1}$ )	Total ammonia ( $\text{mg L}^{-1}$ )	Orthophosphate ( $\text{mg L}^{-1}$ )
Ireland	min 9.0 ( $\text{mg L}^{-1}$ )	65 – 129	max 1.7 0.04 - 1.3	max 0.1 0.015 - 0.03	max 0.12 0.005 – 0.06
Austria	98 – 131	91 - 110	0.9 – 1.4	< 0.01	0.009 – 0.014
Waldaist, Austria	11.3 ( $\text{mg L}^{-1}$ )	102	1.13	0.44	0.015
Lužní Potok, Czech Republic	n.d.	150 64 - 176	1.0 – 22.4	< 0.01 – 0.19	n.d.
Pērļupe 1984	9.14 ( $\text{mg L}^{-1}$ )	n.d.	0.12	0.35	n.d.
Pērļupe 1993	11.8 ( $\text{mg L}^{-1}$ )	n.d.	1.1	0.2	0.02
Pērļupe 1994	9.6 ( $\text{mg L}^{-1}$ )	n.d.	3.9	0.51	0.02
Pērļupe 1995	8.1 ( $\text{mg L}^{-1}$ )	n.d.	0.26	0.12	0.071
Pērļupe 2001	89	325	0.083	2.07	0.023

the Nature Conservation Agency by removing the dams. In 2010 nine new beaver dams were observed in the nature reserve (M. Rudzite, M. Rudzitis, unpublished data).

The decline and disappearance of freshwater pearl mussel *Margaritifera margaritifera* has been reported for all the rivers with populations (Araujo, Ramos 2000; Geist 2005; Rudzite 2001; Rudzite 2005), including Pērļupe. Freshwater pearl mussel is found in Europe and the north-eastern part of North America (Zadin 1952; Glöer, Meierbrook 1998). In western, north-western and central Europe, in some places populations have a potential for self-generation and occur in favorable conditions (Araujo, Ramos 2000; Moorkens et al. 2000; Geist 2005). Both overaged populations and those with recruitment are found in the north of Russia (Bespalaya et al. 2007; Makhrov et al. 2010). In Europe, various methods are used to renew the populations, including host fish infection in captive breeding (Scheder et al. 2011), and breeding of juvenile mussels in specialized fish hatcheries (Scriven et al. 2011) or seminatural habitats (Lange, Selheim 2011).

In conclusion, the potential for survival of the Pērļupe pearl mussel population is poor. The decline of the population has occurred over the last 30 years. Ageing of the population was shown for both living and non-living (empty shells) population. The main reasons for the decline are pearl fishing, insufficient water quality and impact of beavers.

To avoid extinction of the population in Pērļupe, it is necessary to improve the environmental conditions and to promote regeneration of the population. Pērļupe is part of the river Gauja basin, where pearl mussel has lived and in some tributaries is still living. The pearl mussel host fish – Atlantic salmon *Salmo salar* and brown trout *Salmo trutta* still live in these rivers. The population will have a chance to recover if the river ecosystem improves.

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