# FRESHWATER PEARL MUSSEL: DISTRIBUTION AND STATE OF THE POPULATIONS IN FINLAND

P. Oulasvirta
*Alleco Ltd., Mekaanikonkatu 3, FIN-00810 Helsinki, Finland*
*panu.oulasvirta@alleco.fi*

Information on the present distribution and status of the threatened freshwater pearl mussel (*Margaritifera margaritifera*) populations in Finland was gathered. The data from the populations are based both on the available results of the recent field investigations and on the written and oral information on the historical pearl fishing. The records of *M. margaritifera* were classified into three categories: A. Rivers with confirmed populations and recruitment of young mussels, B. Rivers with confirmed populations but no recruitment, and C. Rivers with expected, but not confirmed populations. Altogether 91 category A and B rivers were recorded, out of which 31 contained breeding mussel populations. In addition, 83 rivers were classified as category C rivers. Most of the present *M. margaritifera* rivers are located in the northern part of the country. In southern Finland, freshwater pearl mussel is known only from seven rivers at the moment, and recruitment of young mussels takes place only in one river. In northern Finland, the state of the populations varies between catchment areas. In some areas, the species is near extinction, while in other areas abundant and viable populations are still found. However, disturbances in recruitment are common in many of the northern Finland rivers, too.

*Key words:* Finland; *Margaritifera margaritifera*; distribution; status; recruitment

## INTRODUCTION

The freshwater pearl mussel (*Margaritifera margaritifera*) has been protected in Finland under the Nature Conservation Act since 1955. The species is also listed in Annex II of the European Union Habitats Directive as a species whose habitat must be protected for its survival. Despite the protection, the freshwater pearl mussel populations have been declining almost everywhere in its original range. According to some estimates, the decline of known populations in central and southern Europe is as high as 90% (Bauer, 1988). In Finland, the decline of the populations was estimated to be ca. 70 % vs. the situation at the beginning of the 20$^{th}$ century (Valovirta, 2006a). Indeed, the 1955 Act protected *M. margaritifera* in Finland from pearl fishing but not from destruction of its habitat. Since the era of pearl fishing, the reasons for the declining populations have included the clearing of rivers for timber floating, the construction of hydropower plants, eutrophication and pollution of the rivers, the building of forest roads, and other forestry operations such as drainage of forest and peatlands, which have led to silting of the rivers.

Although there is general awareness of the negative development of freshwater pearl mussel populations in Finland, the knowledge of the state of the populations is scattered, and the comprehensive picture from the whole country has been missing. The most complete record of freshwater pearl mussel populations in Finland is probably in the Museum of Natural History in the University of Helsinki. In addition, at least some of the Regional Environment Centres and the Metsähallitus Natural Heritage Services Lapland have their own databanks. These databanks have been complemented by the results of recently conducted investigations, both those I have been involved in (Oulasvirta et al., 2006 and 2008; Oulasvirta, 2004, 2005 and 2006), and the surveys carried out by Metsähallitus Natural Heritage Services Lapland, Regional Environment Centres and the joint research team of WWF Finland and the Museum of Natural History (unpublished data). The objective of this paper has been to summarize all these new data as well as older records of the distribution and state of the freshwater pearl mussel populations in Finland.

## MATERIALS AND METHODS

The distribution of the freshwater pearl mussel presented here is based both on the results of field investigations and on the historical data on pearl fishing. Pearl fishing in Finland, and especially in the northern part of the country Lapland, has been documented for example by Itkonen (1948), Keltikangas (1977), Fellmann (1906, 1910), Montonen (1985), Storå (1989, 1995), Heikkinen (1999), and Oulasvirta et al. (2006). Information on the old time pearl fishing was obtained also from the archives of the Finnish Museum of Hunting, Finland.

Much of the data concerning Lapland were received from two Interreg mapping projects carried out in 2003-2005 and 2007 (Oulasvirta et al., 2006; Oulasvirta, 2006 and 2008). These projects provided updated information on the distribution and state of the freshwater pearl mussel populations in five big catchment areas, the Tana, Neiden, Pasvik, Lutto (Tuloma) and Tornionjoki, which flow in the cross-border areas of Finland, Sweden, Norway and Russia. The information from other river catchments in Lapland is based mainly on the findings of the joint research team from WWF Finland and the Museum of Natural History (Valovirta and Huttunen, 1997), and on the unpublished data of the Metsähallitus Natural Heritage Services, Lapland and Lapland Regional Environment Centre. Also, the data concerning southern and central Finland are based mainly on the findings of the joint research team from WWF Finland/ Museum of Natural History. Updated information from the Iijoki River and Oulujoki River catchments, in central parts of Finland, was obtained also from the Kainuu Regional Environment Centre/ Friendship Park Research Centre and Metsähallitus Natural Heritage Services, Ostrabothnia.

I have classified the freshwater pearl mussel rivers into three categories. Category A contains those rivers where the presence of freshwater pearl mussel population has been confirmed by field investigations, and in which the population is reproducing. The actual rate of recruitment in freshwater pearl mussel populations has been studied in few rivers in Finland. However, I have generally classified into this category almost all the rivers where small mussels (< 50 mm) were detected. Thus, although a certain river may be classified as a category A river, the level of recruitment in the population would not necessarily be adequate in the long run. In the category B rivers, the presence of freshwater pearl mussel has also been confirmed by field studies. In these rivers, however, there is either no recruitment or we have no information about it. In some cases, I included into this group also such rivers where small mussels can occasionally be found, but the population is clearly aged, and the level of recruitment is far from sustainable. Category C contains rivers where we have reliable knowledge of freshwater pearl mussel populations, but the presence of the mussels has not beenconfirmed after 1990. Reliable knowledge on them is, for instance, well documented historical pearl fishing in the river or a sample of an empty shell. Also, such rivers in which the population has been confirmed in field surveys, but it has been more than 20 years since the last inspection are included into this category. I made some exceptions, however. For instance, if the environment in the river has been drastically changed since the pearl fishing era, I did not include the river into this category. Such are most of the renowned pearl fishing rivers in southern Finland. On the other hand, in more pristine areas like Lapland, category C contains rivers where we still can expect to find populations not currently registered.

## RESULTS

Today, there are altogether 91 freshwater pearl mussel rivers in Finland (categories A and B, Table 1). Recruitment of juvenile mussels (category A) is underway in 31 rivers. In addition, the number of rivers with reliable, but not confirmed data on freshwater pearl mussel (category C) is 83 (Table 1). Most of the present-day freshwater pearl mussel rivers in Finland are located in Lapland, i.e. the northern part of the country (Fig. 1). South from Lapland, freshwater pearl mussel is known only from 27 rivers in 10 different catchment areas (Table 1, Fig. 2). However, most of these rivers are located in the Iijoki River area, central Finland, and only seven freshwater pearl mussel rivers are known from southern Finland. Moreover, freshwater pearl mussel has not been reproducing for decades in southern Finland, except in one small brook in the Kokemäenjoki River basin. In some rivers however the populations have probably become extinct quite recently. For example, the Pyhäjoki River

in Ostrabothnia was known to contain freshwater pearl mussels in the 1980s, but the inspection ca. 10 years ago detected no mussels there anymore (E. Mäenpää, West Finland Regional Environment Centre, personal communication). The freshwater pearl mussel may have disappeared recently also from the middle and lower courses of the Karvianjoki River: during the investigations in 2004–2005, no freshwater pearl mussel was observed in the sites where the species had existed in the 1980s (Oulasvirta, 2005). The population in the Ähtävänjoki River is also declining rapidly: where in the 1980s the population contained ca. 50000 mussels (Valovirta, 1987), it is now roughly half of that (J. Pakkala, West Finland Regional Environment Centre, personal communication). The southernmost population in Finland is in the Karjaanjoki River, where an aged population of ca. 1000 mussels lives (Valovirta, 2006b).

**Table 1**. Number of *M. margaritifera* rivers in different catchment areas in Finland at present. Class A. Confirmed freshwater pearl mussel rivers with recruitment of young mussels. Class B. Confirmed freshwater pearl mussel rivers with no recruitment, or recruitment level very low, or recruitment not confirmed. Class C. The presence of *M. margaritifera* has not been confirmed after 1990. Catchments located in southern and central Finland are with grey background. The numbers of the catchment areas are as in Figures 1 and 2

| | **Catchment area** | **Class A** | **Class B** | **A+B** | **Class C** | **A+B+C** |
|---|---|---|---|---|---|---|
| 1 | Karjaanjoki | | 1 | 1 | | *1* |
| 2 | Kiskonjoki | | 1 | 1 | | *1* |
| 3 | Kokemäenjoki | 1 | 1 | 2 | | *2* |
| 4 | Karvianjoki | | 1 | 1 | *2* | *3* |
| 5 | Lapväärtinjoki | | 1 | 1 | | *1* |
| 6 | Ähtävänjoki | | 1 | 1 | | *1* |
| 7 | Pyhäjoki | | | 0 | *1* | *1* |
| 8 | Oulujoki | | 2 | 2 | *10* | *12* |
| 9 | Iijoki | 1 | 17 | 18 | *3* | *21* |
| 10 | Kem (Karelia) | | | 0 | *2* | *2* |
| 11 | Simojoki | | 1 | 2 | | *2* |
| 12 | Kemijoki | 12 | 21 | 33 | *35* | *68* |
| 13 | Tornionjoki | 2 | | 2 | | *2* |
| 14 | Teno | 2 | 1 | 3 | *1* | *4* |
| 15 | Näätämö | | 1 | 1 | *3* | *4* |
| 16 | Lutto (Tuloma) | 13 | 9 | 22 | *21* | *43* |
| 17 | Koutajoki | | 1 | 1 | *5* | *6* |
| | **TOTAL** | **31** | **60** | **91** | ***83*** | ***174*** |

Iijoki catchment area in central Finland is the only area outside Lapland where freshwater pearl mussel still exists in several rivers. Juvenile mussels were found at least from one river (P-L. Luhta, Metsähallitus Natural Heritage Services, Ostrabothnia, personal communication), but most likely there are also other reproducing populations. For instance, in the Livojoki River, which probably contains the biggest population of freshwater pearl mussels in the whole Iijoki river system, the youngest mussel detected in 1989 surveys was 12-13 years old (Valovirta, 1990). Thus, it is possible that the population in River Livojoki is still reproducing, but no confirmed information was available on that.

In Lapland, the range of the freshwater pearl mussel covers almost all the main catchment areas. The species is missing only from the Pasvik and Uutua (Munkelva) catchments. In Pasvik, the absence of the freshwater pearl mussel may be natural, although it is interesting, since the parts of the Pasvik catchment in Norway and Russia contain several freshwater pearl mussel rivers with viable populations (Oulasvirta et al., 2006; Oulasvirta, 2006). However, from the Finnish part of the Pasvik catchment, there is not a single finding of the freshwater pearl mussel? and neither does the documented history of pearl fishing know of pearl fishing practiced there. By contrast, the Uutua River has been mentioned as a pearl fishing river (e.g. Storå, 1989). However, during the field surveys conducted by the Metsähallitus Natural Heritage Services Lapland in 1998, no mussels were found (Mela, 2006). Thus, it is obvious that the freshwater pearl mussel population has vanished from the Uutua River.

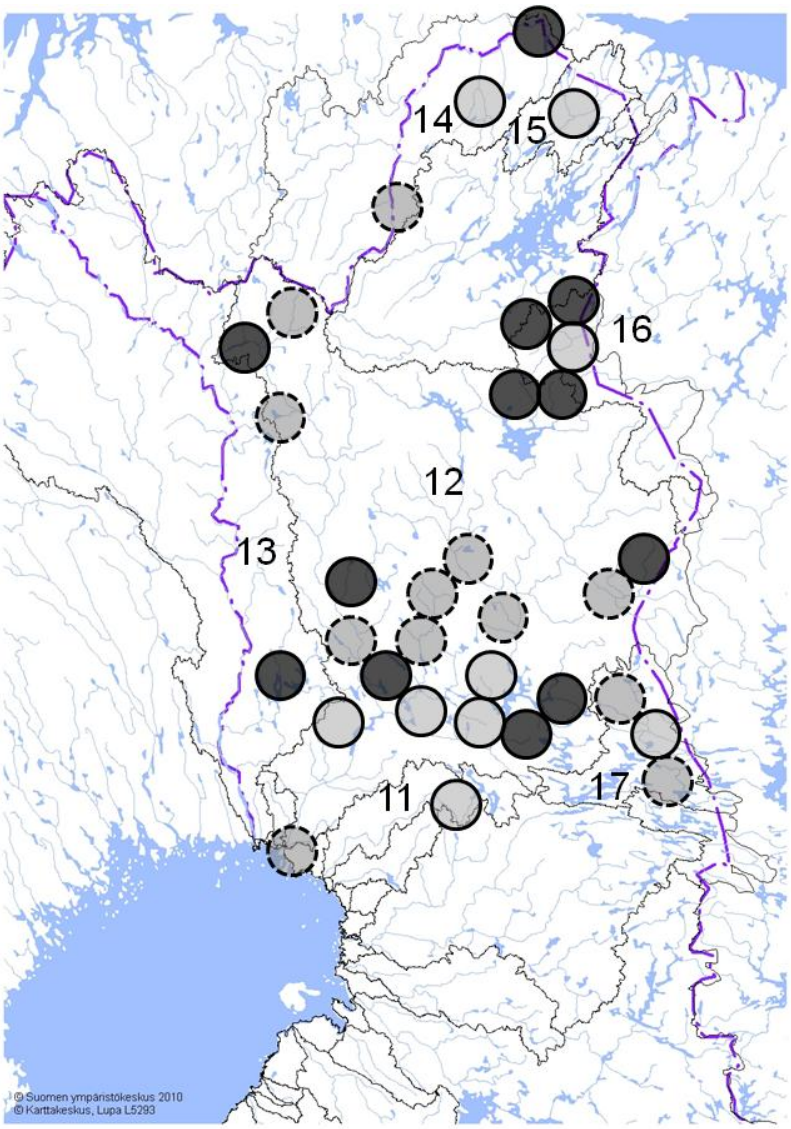


**Fig. 1**. Current distribution of the freshwater pearl mussel in Finnish Lapland. Black circles indicate class A rivers, grey circles – class B rivers, and dash-line grey circles – class C rivers (see Table 1). Note that each circle (diameter 35 km) may include several rivers. The catchment areas are delineated with black borders. The numbers of the catchments are as in Table 1

Most of the freshwater pearl mussel rivers in Lapland are located in the catchments of the Kemijoki and Lutto Rivers (Table 1, Fig. 1). At the moment, the most comprehensive knowledge of populations is from the Lutto and Tornionjoki river catchments (Oulasvirta et al., 2006 and 2008; Oulasvirta, 2006). The Lutto River and its tributaries represent the upper courses of the big Tuloma River, which flows to the Barents Sea. From Lutto area, 22 freshwater pearl mussel rivers are known today. Recruitment is known to take place in 13 rivers (Table 1). However, in the Lutto main channel, the level of recruitment is very low. Most likely this is due to the hydropower dam built in lower courses of the Tuloma, Russia, in the 1960s, which prevents the Atlantic salmon (*Salmo salar*) from ascending the Finnish part of Tuloma. Golubeva and Golubev (2009) have reported about the state of the freshwater pearl mussel populations in the Tuloma catchment in Russian territory. Populations in good condition are found, for example, from the Ulita and Kola Rivers, while the state of the population in the Lutto River on the Russian side is the same as or even worse than in Finland. Both Ulita and

Kola are located downstream from the Upper Tuloma hydropower plant, i.e. in the area where Atlantic salmon can still reach. This fact supports the hypotheses that the dam is the reason for the breeding problems in the freshwater pearl mussel population in the upper courses of Tuloma. In the tributaries of Lutto, the host fish for the freshwater pearl mussel is the local brown trout (*Salmo trutta*).

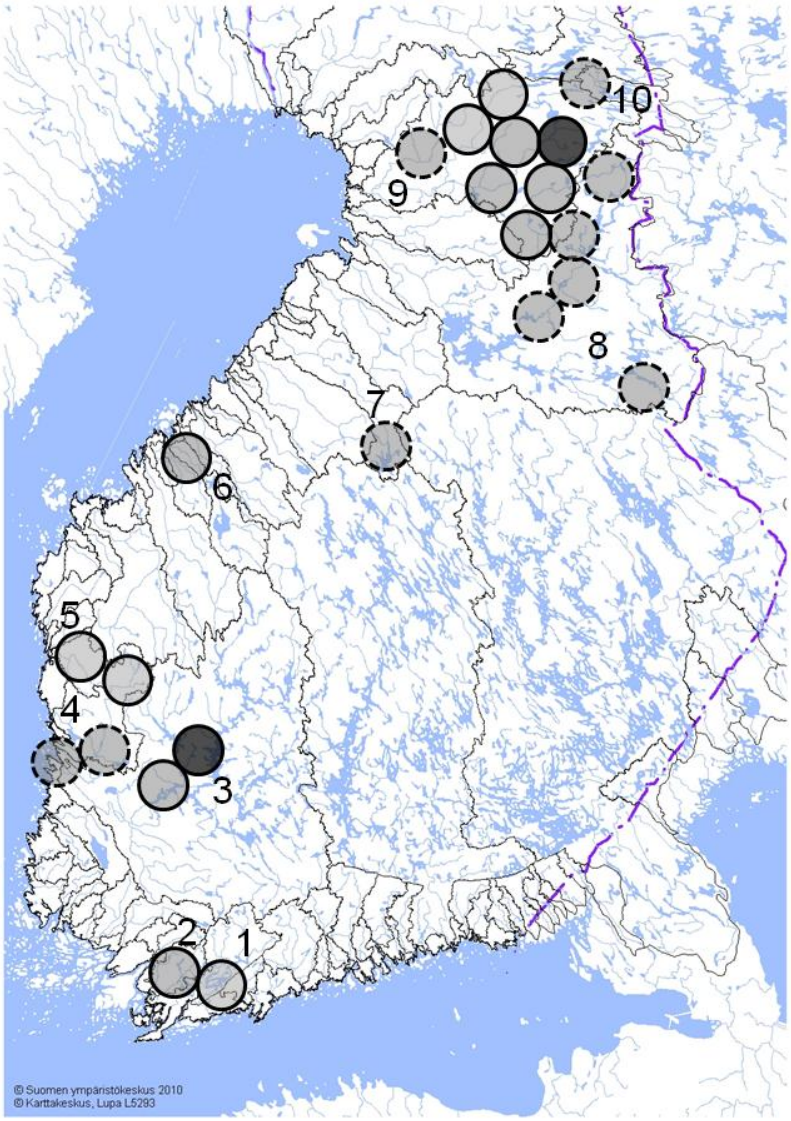


**Fig. 2.** Current distribution of the freshwater pearl mussel in southern and central parts of Finland. Black circles indicate class A rivers, grey circles – class B rivers, and dash-line grey circles – class C rivers (see Table 1). Note that each circle (diameter 35 km) may include several rivers. The catchment areas are delineated with black borders. The numbers of the catchments are as in Table 1

In the Tornionjoki river basin, the known distribution of the freshwater pearl mussel is restricted to three small brooks, two of which are located in Finland and one in Sweden (Oulasvirta et al., 2008). Both rivers in Finland contain viable freshwater pearl mussel populations. In one of the rivers, the maximum density of the freshwater pearl mussel exceeded 1000 specimens $m^{-2}$, which is probably one of the highest densities ever reported (Oulasvirta et al., 2008).

In the Neiden River, the state of the freshwater pearl mussel population is critical. During the investigations conducted in 1998 and 2004-2005, only 14 specimens were found in the main channel and none in the tributaries (Oulasvirta et al., 2006; Oulasvirta, 2006; Metsähallitus Natural Heritage Services, Lapland, unpublished data). All the specimens in the main channel are old and located far from each other.

In the Finnish part of the Teno catchment, only three rivers are now known to contain the freshwater pearl mussel. Two rivers, belonging to the same sub-catchment, were found during the Interreg project in 2005 (Oulasvirta et al., 2006). These populations, located near Lake Pulmanki, are the northernmost populations in Finland, and probably among the northernmost populations currently known in the world as well. In 2009, freshwater pearl mussel was found also from the Utsjoki River, tributary of Teno (Juho Vuolteenaho, University of Helsinki, personal communication). On the other hand, old pearl fishing sites in the Inarijoki River turned out to be empty in the surveys conducted in 1999 (Metsähallitus Natural Heritage Services, Lapland, unpublished data).

Kemijoki river catchment covers more than half of the Finnish Lapland. Currently, 33 freshwater pearl mussel rivers are known there, out of which 12 populations are known to contain juvenile mussels (Table 1). However, especially here, in the Kemijoki catchment, we have large areas not yet investigated (Fig. 3). Thus, it is possible that in the future more populations will be found. Like in Lutto, hydropower engineering has prevented salmon from ascending the Kemijoki River. As a consequence, the freshwater pearl mussel populations in Kemijoki catchment today are entirely dependent on brown trout, and are found in tributaries only.

In Finland, the freshwater pearl mussel has become totally extinct at least in the Kymijoki, Porvoonjoki, Eurajoki, Perhonjoki, Lestijoki, Kalajoki and Siikajoki river catchments, which had, according to the archives of the Museum of Hunting, been earlier renowned for their pearl fishing. Besides these, freshwater pearl mussel has most likely disappeared from many other river basins in southern Finland as well. For example, an empty shell of the freshwater pearl mussel was found in the Mankkaa River in 2008, indicating that the mussel had probably existed very close to the city of Helsinki less than 50 years ago (Laaksonen et al., 2008). As already mentioned, freshwater pearl mussel may have disappeared recently also from the Pyhäjoki River, and from the middle and lower courses of Karvianjoki river catchment.

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## DISCUSSION

During the last decades the freshwater pearl mussel has declined dramatically in Finland. Valovirta et al. (2003) have reported that at the beginning of the 20$^{th}$ century, the species was found in more than 200 rivers, and in the modern time only in ca. 70 rivers. The updated information of this study supports the earlier estimates. We must remember however that the number of freshwater pearl mussel streams (91) presented in this paper, contains also the new findings not reported earlier. The state of the freshwater pearl mussel is critical, especially in southern Finland, where the last remaining populations are quickly vanishing. It is clear that only immediate and extensive restoration efforts, including measures in the catchment areas, can save the species in southern Finland.

Besides southern Finland, also most of northern Finland's populations are threatened in one way or another. The reasons for the negative development are multitudinous. The pearl fishing practiced before 1955 has certainly had negative influence on certain populations. However, since the pearl fishers collected mainly big sized old mussels and left juvenile mussels in the river, pearl fishing alone rarely destroyed the whole population. In such rivers where successful recruitment takes place rarely – once a decade or even more rarely – pearl fishing may have been the original and principal reason for the process leading to the extinction, however. For example, the conditions in the Neiden River could be suitable for the freshwater pearl mussel, but, perhaps because of the earlier pearl fishing, the number of mussels today is too low for them to survive.

After the protection of freshwater pearl mussel against pearl fishing was introduced in 1955, the reason for the decline of the populations has been the destruction of the river environment. This has included dredging of rivers for timber floating, construction of hydropower plants, eutrophication, building of forest roads, and other forestry operations such as drainage of forest and peatlands, which have led to

silting of the rivers. In Finland, where drainage operations have been extensive, they are probably the major single cause of population extinction or decline. These same activities are still threatening the remaining populations, also in the remote wilderness areas in Lapland. For example, the last two freshwater pearl mussel rivers in the Tornionjoki river basin are extremely valuable in terms of protection, but still threatened and already partly affected by the forestry operations in the surroundings.

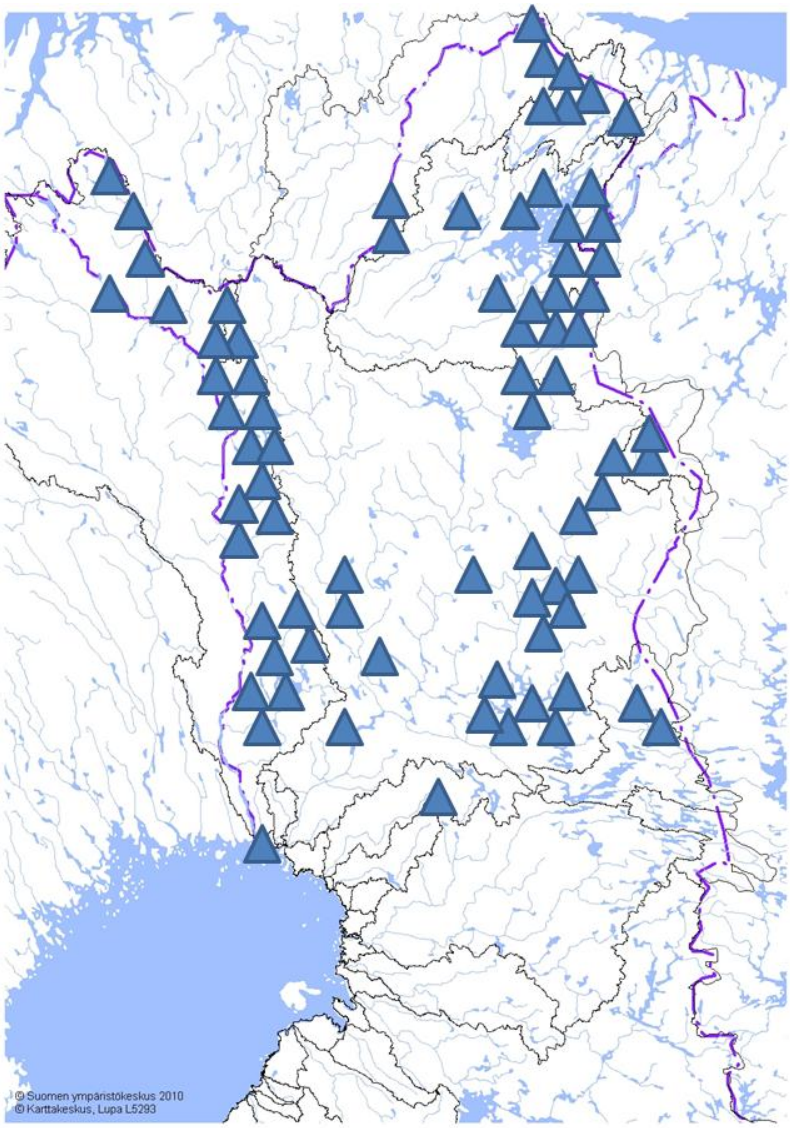


**Fig. 3**. Location of the sites where the distribution of the freshwater pearl mussel has been investigated in the field in Lapland. The map is based on the data of Valovirta and Huttunen (1997), Oulasvirta et al. (2006), Oulasvirta et al. (2008), Oulasvirta (2008), and on unpublished data of the Lapland Regional Environment Centre and the Natural Heritage Services, Lapland

In Table 2, I have summarized the main threats for the freshwater pearl mussel populations in different catchment areas in Finland. Also, the estimated numbers of mussels in different catchments are presented in Table 2. One should note that the mussel numbers presented in Table 2 are only rough estimates based on the available, quite inadequate data on the populations. The actual population size surveys have been conducted only in a couple of rivers in Finland. Moreover, possible findings of new

populations in the future may change these figures greatly. As seen from Figure 3, especially the Kemijoki and Teno catchments still contain large unsurveyed areas. Still, the number of freshwater pearl mussels is small compared to the estimated freshwater pearl mussel numbers in Sweden (>8 million specimens) and Norway (143 million specimens) (Geist, 2005; Larsen, 2005; Direktoratet for naturforvaltning, 2006). Also, the number of known freshwater pearl mussel rivers or rivers with breeding populations is much higher in Sweden (550 rivers/ ca. 140 breeding populations) and Norway (485/ ca. > 300 breeding populations) (Henrikson, 2009; Larsen, 2009). From Russia, the available knowledge of the populations is not as good as from Norway or Sweden. However, according to Ziuganov (1994) the population in the Varzuga River in the Kola Peninsula alone contains a viable population of more than 100 million mussels. During the Interreg project in 2003-2005 viable and abundant populations were found also from the Pechenga area, Russia (Oulasvirta et al., 2006; Oulasvirta, 2006).

**Table 2.** The estimated numbers of living pearl mussels in different catchment areas in Finland, and a summary of the state of the populations and the factors threatening them. The data on the mussel numbers is partly based on the articles of Oulasvirta et al. (2006), Valovirta (1984, 1987) and on personal communications with Ilmari Valovirta (Museum of Natural History) and Eero Mäenpää (West Finland Regional Environment Centre)

| Catchment | No of mussels | State of the populations, main threats and other remarks |
|---|---|---|
| 1. Kiskojoki | ? | No recruitment; vanishing, threats/reasons for decline [2,3,5] |
| 2. Karjaanjoki | ca. 1000 | No recruitment; vanishing, threats/reasons for decline [2,3,5] |
| 3. Kokemäenjoki | ca. 50000 | Recruitment in one brook, elsewhere vanishing; threats/reasons for decline [2,3,5] |
| 4. Karvianjoki | > 500 | No recruitment; vanishing, threats/reasons for decline [2,3,5] |
| 5. Lapväärtinjoki | < 500 | No recruitment; vanishing, threats/reasons for decline [2,3,5,7] |
| 6. Ähtävänjoki | 10000–50000 | No recruitment; vanishing, threats/reasons for decline [2,3,5] |
| 7. Pyhäjoki | ? | Extinct (?); reasons [2,3,5] |
| 8. Oulujoki | ? | Populations threatened [2,3,5]; Large uninvestigated areas |
| 9. Iijoki | >10000 | Recruitment at least in one brook; Populations threatened [3,4,5] |
| 10. Vienan Kemi | ? | State of the populations unknown |
| 11. Simojoki | >1000 | Populations threatened [3,4] ; Large uninvestigated areas |
| 12. Kemijoki | >100000 | Populations threatened [3,4,5,6]; Large uninvestigated areas |
| 13. Tornionjoki | 50000–100000 | Populations threatened [3] |
| 14. Teno | ? | Large uninvestigated areas; Reasons for decline [1(?)] |
| 15. Näätämö | <100 (?) | No recruitment; vanishing; threats/reasons for decline [1(?), 7] |
| 16. Lutto (Tuloma) | 500000–1000000 | Vanishing from the main channel, threats/reasons for decline [3,5,6] |
| 17. Koutajoki | ? | State of the populations unknown |

1. Pearl fishing before 1955
2. Agriculture
3. Forestry (including drainage operations, building of forest roads and clearing of rivers in the past)
4. Peat harvesting
5. Hydropower
6. Gold and other mining
7. Small population size

## CONCLUSIONS

The threatened species freshwater pearl mussel will be largely vanishing from Finland in the next few decades. In order to save the remaining populations, a management plan for saving the species is required. The management plan should include step-by-step program of how to protect the species in Finland. This would involve surveys in the yet uninvestigated areas, monitoring of the key populations and prohibition of all the activities, both in the river and in its catchment, which may threaten the freshwater pearl mussel populations.

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