Acta Biol. Univ. Daugavp., Suppl. 3, 2012: 3 – 13.
ISSN 1407 – 8953

THE CURRENT STATUS OF COREGONIDAE IN THE LAKES OF LATVIA

Ēriks Aleksejevs[1], Jānis Birzaks[2]

[1,2] Institute of Food Safety, Animal Health and Environment „BIOR", Fish Resources Research Department, Rīga, Latvia, eriks.aleksejevs@bior.gov.lv

The vendace is the only one of the Coregonidae fish species native in Latvian lakes, which has been naturally sustainable. Vendace and 8 another non- native fish species from this family have been released in 112 lakes from at least 1888. In the majority of cases the results of their introduction proved to be ineffective; self-sustainable Coregonidae fish populations established only in 2 or 2% of these lakes.
Currently vendace or ripus and whitefish populations exist in 13 and 2 lakes respectively. It is possible that introduced peled populations may exist in individual lakes.
Overall in the period since the 1950's the distribution of the Coregonidae fish species in Latvian lakes has diminished, and they have been found only in 13 lakes after 1990. In Latvian conditions the distribution of Coregonidae fish has been significantly influenced by two factors - a high temperature in the upper water levels of lakes during the summer period and a low level of oxygen in the water below thermocline in stratified lakes. A massive vendace summer-kill has been observed in individual lakes.

Key words: Coregonidae, vendace, lakes, Latvia

INTRODUCTION

From data obtained in 1930-ies, we can surmise that only vendace *Coregonus albula* (Linnaeus, 1758) had naturally sustainable populations in Latvian lakes, and could be found in 15 to 30 lakes. (Bērziņš, 1938; Mansfelds, 1936). Meanwhile river spawning whitefish *Coregonus sp.* migrated mainly through coastal lakes (Kačalova et al., 1962).

The distribution of Coregonidae fish in Latvian lakes has been significantly determined by anthropogenic activity, i.e., the introduction of fish. The artificial reproduction of vendace and the introduction of other Coregonidae fish (Andrušaitis, 1960) began in the territory of Latvia since at least 1888. In recent years fish breeders have recommenced the release of various fish from this family, though often of unknown origin, into natural bodies of water. Nowadays the nomenclature of Coregonidae fish (Kottelat & Freyhof, 2007) also has significantly changed. That's why the accurate determination of a species after the capture of individual specimens of this family of fish can be difficult.

Overall, the distribution and occurrence of Coregonidae fish in the territory of Latvia has diminished. It is thought that this may have been caused by the eutrophication of lakes and climate changes (Leinerte, 1988; Aleksejevs & Birzaks, 2011).

The goal of this work was to collate and analyse existing information about the distribution and occurrence of Coregonidae fish,

using historic data, fishery statistics and the results of research fishing in the period after 1990. This was used to describe the status of the populations of this family in Latvian lakes nowadays.

STUDY AREA

According to data of Latvian Institute of Amelioration obtained in 1970-ies, in Latvia there are 2256 lakes with a total area of approximately 100000 hectares, with the water surface area being larger than or equal to 1 hectare. Only 124 of these are larger than 100 hectares. Most of the lakes are located in the highlands, with a great many being in Southeastern Latvia – in the Latgale highlands.

MATERIALS AND METHODS

Archival data from the Baltic Fish Conservation and Reproduction Administration about the acclimatization and catch of Coregonidae fish for the period from 1946 until 1990, as well as "BIOR" archival materials for the period from 1990 until 2011 were collated. In total, haul statistics are available for 679 lakes, but artificial restocking and introduction data concerning fish – for 412 lakes.

From 1990 to 2012, test fishing was done in 316 lakes using nets with varying mesh sizes (8 – 70 mm). Usually 1.5 m deep bottom gillnets were used in all lakes, but in lakes, in which vendace could potentially be encountered, up to 6 m deep bottom gillnets and floating gillnets were used as well. Coregonidae fish releases have been made in 88 and natural vendace populations have been mentioned in 15 lakes out of all surveyed lakes. In total, Coregonidae fish have been found in 16 lakes since 1990 (Table 1, Figure 1).

Table 1.

The morphometric characteristics and Coregonidae species occurrence in the lakes of Latvia

No	Lake	Area (ha)	Maximal depth (m)	Average depth(m)	Fish species
1	Lielais Nabas	70	6.5	3.3	peled?
2	Mazais Nabas	69	5.2	2.7	peled?
3	Usmas	3850	27.0	5.4	vendace
4	Alauksta	783	7.0	3.3	whitefish
5	Alūksnes	1540	15.2	7.1	vendace
6	Kālezers	407	14.8	5.3	whitefish
7	Sventes	726	27.7	7.8	vendace
8	Ārdavas	231	14.0	4.6	vendace
9	Balta	57	34.3	7.1	vendace
10	Cērmenes	222	31.0	9.3	vendace
11	Cērpa	133	14.0	5.8	vendace
12	Drīdža	753	65.1	12.8	vendace
13	Dubuļu	9	25.2	5.4	peled, whitefish
14	Ežezers	1092	21.0	6.4	vendace
15	Lejas	171	34.0	8.2	vendace
16	Rāznas	5760	17.0	7.0	vendace, whitefish
17	Sīvera	1730	24.5	6.3	vendace
18	Stirnu	149	25.8	7.7	vendace
19	Nirzas	552	21.0	8.2	vendace
20	Šķaunes	247	12.6	5.7	peled

RESULTS AND DISCUSSION

Vendace and ripus (*Coregonus ladogae* Pravdin, Golubev & Belyaeva, 1938)

The occurrence of vendace in the territory of Latvia (Puzes and Usmas lakes) had already been mentioned in the 19th century (Kawall, 1858). A survey of Latvian fish done in 1930-ties shows that vendace could be encountered in Alūksnes and Usmas lakes, and it also mentioned that it and lake smelt *Osmerus eperlanus* (Linnaeus, 1758) can be encountered together or individually in about 30 lakes mainly in Eastern Latvia (Mansfelds, 1936). Later 15 lakes were mentioned in a popular science article about vendace: Alūksnes, Cērmenes, Drīdža, Ilzas, Jezinakas, Garais, Lejas, Lielais Gusena, Limbažu Lielezers, Puzes, Rāznas, Rušons, Sīvera, Sventes and Usmas (Bērziņš, 1938). Ilza and Garais lakes cannot be accurately identified, as a number of water bodies in Eastern Latvia have the same name. Judging by their depth, they are obviously the Geraņimovas - Ilzas and one of the lakes in Piedruja or Robežnieki municipality with the name Garais.

A fisheries assessment of 549 Latvian lakes was done from 1951 until 1956. The goal was to assess the distribution and occurrence of various species of fish, and commercial fishing and resident survey data was collated as well. Fish occurrence was assessed in categories from common to rarely occurring. The results of this were that vendace was ascribed to 39 lakes, including lakes where they were artificially propagated (Kotov et al., 1958). The results showed that at the time vendace was already occurring rarely in 29 of surveyed lakes.

Overall, in the fisheries research conducted in the 1950-ies, vendace was found in 12 lakes: in Alūksnes, Cērpa, Drīdža, Ežezers, Lielais Gusēna, Nirzas, Puzes, Rāznas, Sīvera, Stirnas, Sventes and Usmas. It was also ascribed to Geraņimovas - Ilzas and Rušona lakes, although none was caught during test fishing there (Laganovska, 1957; Vadzis et al., 1967; Vadzis et al., 1968; Nikanorov, 1962). In the period from the 1960-ies until 1989, there were no scientific publications about the occurrence of vendace in Latvian lakes. Obviously surveys about this were not done.

In surveys undertaken from 1990 until 2012 vendace was found in 10 lakes: Alūksnes, Cērpa, Drīdža, Ežezers, Lejas, Nirzas, Stirnas, Rāznas, Sventes and Usmas.

However, vendace couldn't be found anymore in Puzes, Geraņimovas - Ilzas and Rušona lakes. The local residents who were surveyed also doubted their occurrence in these lakes. In test fishing, vendace was not found in Ārdavas, Cērmenes and Sīvera lakes either. However, judging from the data from the survey of local residents, their populations still exist in these lakes, in a similar way as in Lake Balta, where surveys have never been done (Figure 1).

Vendace was mentioned in 24 lakes in the haul statistics from 1946 until 2011. Since 1990, after the abolition of the state's Fisheries Company, the number of lakes fished with a beach seine began to diminish rapidly. Since 2004 commercial fishing with a beach seine was banned in Latvian inland waters. As a result of this, vendace was mentioned in only 5 lakes in fisheries statistics in the period from 1991 until 2011.

In the period from 1900 until 1968, vendace were released in 36 lakes, and their release was done as a way of both introducing them, as well as supplementing resources. The introduction of ripus was commenced in 1955 and by 1980 they had been introduced into at least 14 lakes. In total, vendace and ripus were introduced into 45 lakes.

Up till now vendace and ripus in Latvia had been considered as one species (Oreha & Škute, 2007, Plikšs & Aleksejevs, 1998; Nikanorov, 1964). The vendace subspecies ripus *Coregonus albula ladogensis* which was introduced earlier Berg, 1948 is considered to be

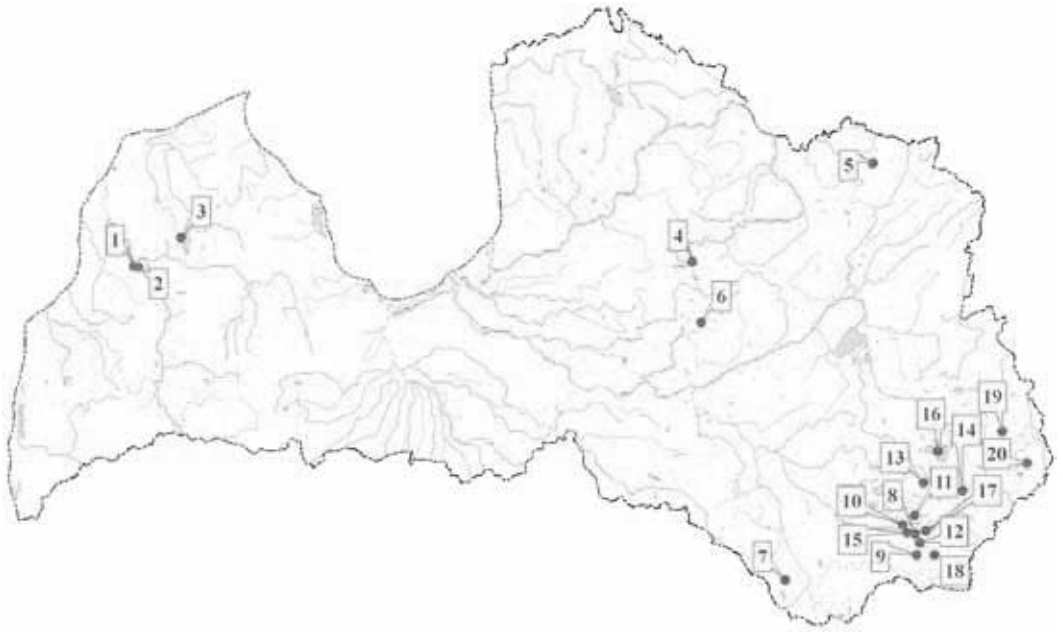

Figure 1. Occurrence of Coregonidae in lakes of Latvia.

a separate species, *Coregonus ladogae* Pravdin, Golubev & Belyaeva, 1938 (Kottelat & Freyhof, 2007). From plastic and meristic parameters, vendace cannot be clearly distinguished from ripus. In most cases genetic research has not been done. That's why, from 1955, when the introduction of ripus was commenced in Latvian lakes, one cannot be certain which one of the species was mentioned. The results from the introduction of ripus are also unclear.

According to the literature data, ripus reaches a standard length of 43 cm in lakes (Kottelat & Freyhof, 2007). However, the morphological features of Coregonidae fish are quite variable and can change in new conditions (Reshetnikov, 1980). There have been situations, when a population developed features of both species after two types of whitefish, which are currently considered to be different species, were introduced into one lake (Shaposhnikova, 1971). The length of vendace or ripus, caught in surveys of Latvian lakes since 1990, has been from 18 to 25 cm. Therefore the introduction of ripus in Latvia can be considered to be unsuccessful. The question of whether the Coregonidae's classification belongs to lakes, where both species could be encountered at some time, remains open.

Despite the relatively intensive artificial breeding and introduction of vendace and ripus, in their population decreasing numbers and size can be observed. If the best vendace catch from test fishing per 100 m^2 of net in summer in the 1950-ies was 68 specimens (Nikanorov, 1960), then the best result, which has been achieved in the past 10 years in summer test fishing per 100 m^2 of net has been only 8 specimens. In the same nets in Lake Stirnas in 2012, the haul of carp-type fish (bream *Abramis brama* (Linnaeus, 1758), silver bream *Blicca bjoerkna* (Linnaeus, 1758), roach *Rutilus rutilus* (Linnaeus, 1758) and rudd *Scardinius erythrophthalmus* (Linnaeus, 1758) was 5 specimens per 100 m^2 of net, but in Cērpa Lake, the proportion of vendace and ciprinids was 1 specimen and 49 specimens respectively per 100 m^2 of net. Meanwhile in Lake Puzes, where vendace weren't found, there were 104 specimens of ciprinids per 100 m^2 of net. Unfortunately,

the authors were unable to find information in the literature from the 1950-ies and 1960-ies about the CPUE of Cyprinidae fish in vendace lakes, which would allow us to deliberate on changes in fish communities overall.

Obviously, as a result of the eutrophication of lakes, their suitability for vendace gradually decreased. But, it should be noted that quite conflicting results have been obtained in surveys. In evaluating the level of eutrophication in lakes according to the volume of total phosphorous in sediments, it was found that it was the highest in Lake Stirnas (Jankēvica et al., 2012). But, when the results of test fishing in 2012 are taken into account, the relatively largest known vendace population in Latvia is in this lake. Lake Stirnas has a distinct thermal stratification. From our observations the oxygen content under the thermocline is greater than 7 mg/l, which is sufficient for the ecological demands of the vendace.

A less favourable situation for the vendace is developing in lakes where there isn't a distinct thermal stratification. For example, the negative influence of raised water temperatures on vendace was already discovered in the 1950-ies in the Rāznas and Sīvera lakes with their large surface area and relatively small average depth (Никаноров, 1960, Пер, 1968). In a similar way to what was mentioned previously, a vendace mass-kill has been noted in the last ten years in several lakes in Latvia during summer, which was obviously caused by high water temperatures in the upper water levels of lakes and a shortage of oxygen in lakes under the thermocline layer.

Changes in vendace numbers in lakes is revealed partly by commercial fishing statistics. A reduction in the catches of vendace could already be observed before the ban of beach seine fishing in 2004. In net fishing in lakes, the minimum allowed mesh size 30 mm from knot to knot is larger than the optimal for vendace fishing, and that's why vendace are stop ever fished in Latvian lakes any more.

The overall increase in the catches of vendace from 1976-1980 and 1994-1996 can be explained by their increased in Lake Rāznas (Figure 2). At first this was possibly caused by artificial reproduction and the introduction of ripus, as well as changes in fishing efforts. The fishing of vendace in Latvian lakes generally has been done irregularly, which is shown by significant haul fluctuations in different years

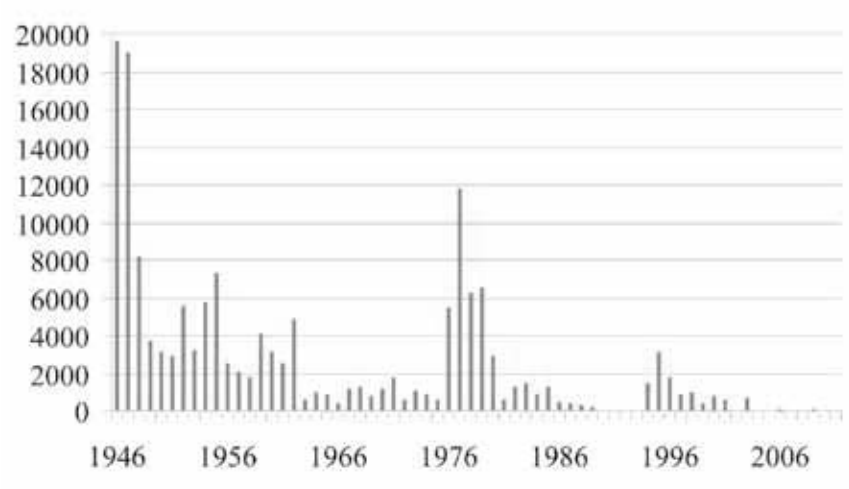

Figure 2. Vendace catches (kg) in the lakes of Latvia.

in various lakes. From vendace catches in the period from 1946 until 2011 in the 24 lakes they were caught relatively regularly in only 6 of them.

Both fishing and survey results indicate that the distribution of vendace and the density of population in Latvian lakes in the last 50 years has gradually decreased.

Whitefishes

In the chronologically oldest publications on fish encountered in Latvia, whitefish has been mentioned as found only in coastal waters, the largest rivers and in some coastal lakes (Mannsfeld, 1930, Mansfelds, 1936). In the period from 1949, they have been rarely mentioned in small numbers in commercial fishing statistics in 5 lakes connected to the sea, where they enter or migrate from coastal waters. Whitefish catches are reported form 16 lakes where whitefish or peled have been introduced. Consequently, it could be considered that whitefish populations in Latvian lakes have been created via their introduction.

Different whitefish species and often of unknown origin have been introduced into Latvian lakes. Peipsi whitefish *Coregonus maraenoides* Polyakov, 1874 from 1899 to 1976 were introduced in 67 lakes. The Ludoga whitefish *Coregonus lutokka* Kottelat, Bogutskaya & Freyhof, 2005 were introduced into one lake in 1956. Whitefish of unknown origin and species from private fish hatcheries were introduced in 3 more lakes (Kālezers, Dubuļu, Alūksnes) from 2006 until 2009.

Overall, the results of the introduction of whitefish have been very ineffective, with a few exceptions. The release of Peipsi whitefish fry in Lake Burtnieku in the 1920-ies and 1930-ies was relatively effective economically, their introduction giving a catch of up to 4.2 t per year. However, after artificial breeding was discontinued their abundance rapidly decreased, the reproduction of whitefish wasn't observed and they disappeared from the lake (Lablaika, 1961). 549 lakes were surveyed in the 1950-ies, whitefish were ascribed to 12 of them, but rarely encountered in each of them (Kotov et al., 1958). At present, self-sustainable whitefish populations have been found in only two lakes – Alauksta and Rāznas. Judging from their morphometric features these could be Peipsi whitefish.

According to commercial catches, which to a certain degree are influenced by changes in fishing effort, the abundance of the whitefish is decreasing in these two lakes as well. In Lake Alauksta, the whitefish population had developed from Peipsi whitefish fry introduced in the 1930's (Sloka, 1961). Peipsi whitefish fry and fingerlings were also released in the lake in the period from 1963 until 1971. In the 1970's, up to 1 t whitefish per year were fished from Alauksta, but in 2010 only 2 kg of this fish were caught (Figure 3).

The whitefish population in Lake Rāznas developed after the restocking of Peipsi whitefish fry and fingerlings in the period from 1956 until 1970. Their maximum catches of 0.8 t was recorded in 1996, but in 2011 only 53 kg of whitefish was caught.

These facts allow for the conclusion that the introduction of whitefish has not been successful in the majority of lakes. Small quantities of them are mentioned in commercial catch statistics, but only in the first years after their release.

Better results from attempts at introducing whitefish have not been obtained in recent years either. Thus, whitefish of unknown origin and species which were released in Kālezers in 2007 were found in 2010. As commercial fishing is being engaged in at this lake, there isn't any information available about the current state of the whitefish population.

Whereas, in Lake Dubuļu (in the territory of

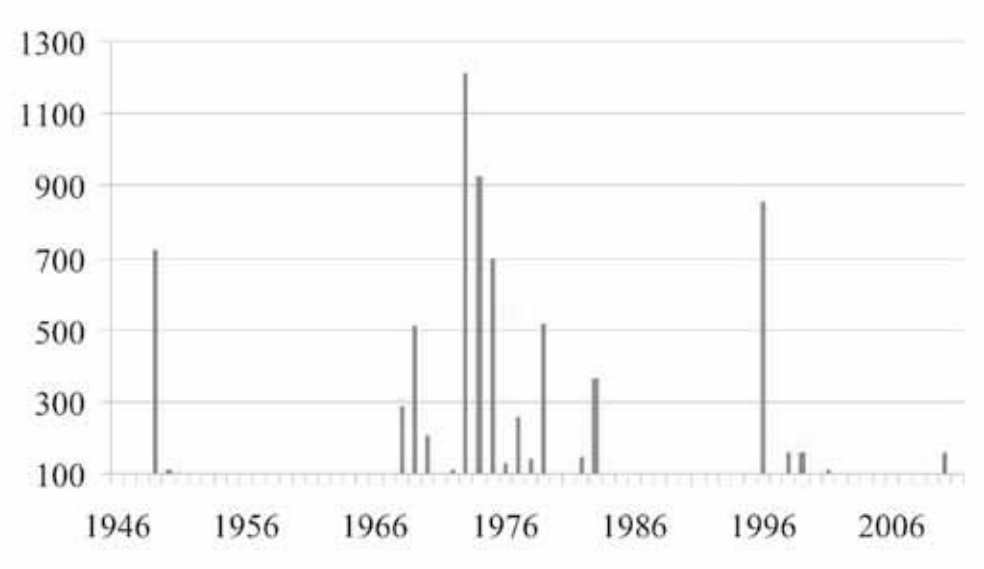

Figure 3. Whitefish catches (kg) in the lakes of Latvia.

Andrupene municipality), whitefish of unknown origin released in May 2009 were found in autumn of the same year. Their average increase in average weight in four and a half months was only 5 g. A deficiency of oxygen was observed in the lake's deepest layers under the thermocline, which obviously disturbed the normal feeding of whitefish. In three test fishing trials in 2010-2012, using a sufficient number of nets for this small lake (9 ha), whitefish were no longer caught.

Overall, the data that we have at our disposal revealed that whitefish was a rare species in Latvian lakes in the 20th century, and that its introduction usually proved to be ineffective.

Peled *Coregonus peled* (Gmelin, 1789)

The peled is an alien fish species in Latvia. It was included in this survey as it was introduced over a longer time period and in greater numbers.

Peled was released in 53 lakes in the period from 1954 until 2011 for acclimatization and ranching purposes. It has been mentioned in catch statistics from 1957 until 1986 in 31 lakes. Judging from commercial fishing statistics, stocks of peled in lakes have existed for a relatively short period, usually only for a few years after their release, i.e., in the majority of lakes they have not developed self-sustainable populations (Figure 3).

In one lake (Kālezers), a single peled caught was mentioned in 1993. Prior to this, peled were fished in this lake in 1972 (305 kg) not long after their regular stocking from 1965 until 1971. Whitefish, which were periodically mentioned in commercial fishing until 1988, were also released in the lake together with peled. Bearing in mind that both species of fish are relatively similar, it's possible that fishermen's have incorrectly recognized the fish (Figure 4).

In Lake Dubuļu as well, peled introduced in the spring of 2009 were obviously caught within about three years, or the surviving number of fish was very small. Thus, in the test fishing undertaken in autumn of 2009, 22% of the 1,000 peled released were caught, with 5% in 2010,

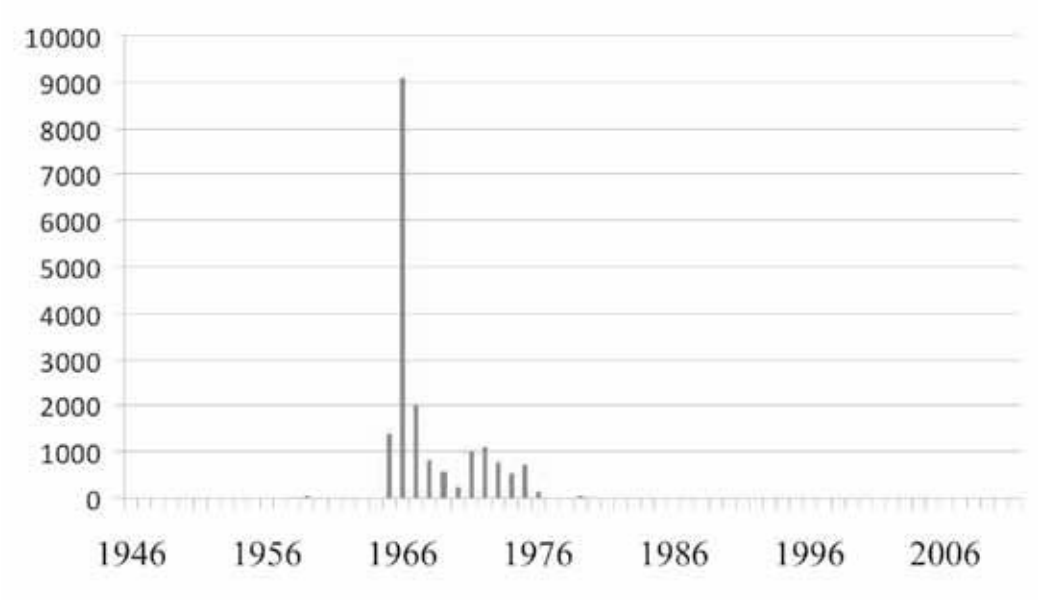

Figure 4. Peled catches (kg) in the lakes of Latvia.

whereas in autumn of 2011 and 2012, peled were no longer found. The peled grew comparatively well as opposed to whitefish which were simultaneously introduced together with them. Their annual increase of average body weight exceeded 100 g. The peled lived in the upper water layers where a shortage of oxygen was not observed and there was sufficient zooplankton required for their feeding.

Peled were still found in Lake Šķaunes in 2007, where they had been introduced in 2004. Information about the introduction results was not available as fishing is not undertaken in this lake.

An unclear situation has developed in relation to two lakes connected to the River Venta. Lake Lielais Nabas is connected to the River Venta by a water course which is about one kilometre long. Lake Mazais Nabas is connected to Lake Lielais Nabas by a water course which is about 0.4 km long. In test fishing undertaken in both lakes in 1999, typical river fish species were found in lakes' fish community, as well as individual specimens of Coregonidae. Judging from their individual morphometric features, these could be peled but not migratory whitefish. The number of gill rakers for the fish which were caught exceeded 50, which corresponds with the number of gill rakers for the Coregonidae fish caught in a branch of the River Venta in 2002. Whereas, for migratory whitefish, which were caught in the River Venta in 2010, the number of gill rakers did not exceed 35. This allows the assumption that naturally sustainable populations of peled had possibly developed in the Lielais and Mazais Nabas lakes. Peled were introduced into Lake Lielais Nabas in 1965 and were mentioned in fishing statistics in 1966 and 1969. However, after their release in both Nabas lakes, fishing had been irregular and not very intensive, and is banned from 2004. The spread of the peled along the River Venta is also possible, with evidence for this being provided by its capture on a meander of the River Venta.

Other coregonidae fish species in Latvian lakes

Other alien Coregonidae fish from the former USSR were introduced into Latvian lakes. The most intensive release of the species was made in the 1960-ies and 1970-ies, when the introduction and acclimatization of species was considered to be an effective fisheries management measure.

Inconnu *Stenodus leucichthys* (Gueldenstaedt, 1772) was introduced in Lake Lielais Stropu in 1957 (Andrušaitis, 1960). It was not found during test fishing done in the lake in 1996. Coregonidae fish were also not reported in catch statistics from 1958 until 2004, when the lake was being fished.

Baikal omul *Coregonus migratorius* (Georgi, 1775) was introduced in 1957 into Mazais Stropu, Dzelzs Stropu and Rušonu lakes. The omul migrated from Lake Rušons and could be encountered in the Cirīša, Geraņimovas-Ilzas and Zalvu lakes (Andrušaitis, 1960). Coregonidae fish, excluding vendace, have not been reported in Lake Rušonu or in any other lakes in fisheries statistics, and have not been found in test fishing in the Ciriša, Geraņimovas-Ilzas, Rušonu and Zalvu lakes.

Muksun *Coregonus muksun* (Pallas, 1814) were introduced in Lake Bruņu in 1973. It hadn't been mentioned in catch statistics from 1973 until 2007 and also wasn't found in the test fishing carried out in 1997.

An introduction of broad whitefish *Coregonus nasus* (Pallas, 1776) and peled hybrid was made in Kālezers in 1977 and 1978 and in Lake Bruņu in 1982. However, no information was received in the following years about the results.

CONCLUSIONS

There has been only one native species representing Coregonidae family in lakes of Latvia (Mansfelds, 1936). It could be found in about 30 lakes, mainly in Eastern Latvia.

Whitefish populations in Latvian lakes were established as a result of their introduction. Judging from their morphological features the donor population was Peipsi Lake whitefish, which according to Kottelat and Freyhof, 2007 is a separate species, the Peipsi whitefish *Coregonus maraenoides* Polyakov, 1874. The existence of a self-sustainable population of peled in two lakes in the River Venta basin is also potentially possible. The introduction of other Coregonidae species in Latvian lakes obviously has been unsuccessful. The results of commercial fishing and surveys show that after release they could be found for a short period.

The number of vendace populations in Latvia in the past 50 years has significantly decreased. Nowadays, they are found in 10 lakes, and could potentially be found in at least 5 more lakes. The eutrophication of lakes and global climate change are possibly the main factors which determine the occurrence of these species of fish and the reduction in their abundance in Latvian lakes.

REFERENCES

Aleksejevs, Ē. & Birzaks, J. 2010. Zivis potenciālie klimata izmaiņu indikatori [Fishes as potential climate chages indicators]. Rakstu krājums. LU 68. zinātniskā konference Klimata mainība un ūdeņi. Rīga, 6-14. (In Latvian)

Aleksejevs, Ē. 2011. Zivju introdukcija un aklimatizācija Latvijā [Introduction and acclimatization of fishes in Latvia]. Latvijas zivsaimniecības gadagrāmata 2010. Rīga, 61-68. (In Latvian)

Andrušaitis, G. 1960. Zivju savairošana un aklimatizācija Latvijā [Breeding and acclimatization of fishes in Latvia]. Latvijas PSR iekšējo ūdeņu zivsaimniecība IV. Rīga, 41-70. (In Latvian)

Bērziņš, B. 1938. Repša dzīve [The life of vendace]. Daba un zinātne. Nr. 6, 178-181. (In Latvian)

Jankēvica, M., Kokorīte, I. & Šīre, J. 2012. Fosfora koncentrācija un tā atrašanās formas Latgales lašveidīgo zivju ezeru nogulumos [The content of phosphorus and its type forms in sediments of Latgale salmonid lakes]. Rakstu krājums. LU 70. zinātniskā konference Latvijas purvu un ezeru pētījumi. 296-299. (In Latvian)

Kačalova, O., Kumsāre, A. & Kundziņš, M. 1962. Lielie ezeri Rīgas apkārtnē [Largest lakes in Riga surroundings]. Rīga, 68. lpp. (In Latvian)

Kawall, H. 1858. Fische in Kurland und an den Küsten der dasselbe begränzenden Ostsee, mit Berücksichtigung von Livland. Das Inland. 23. Jahrg. Dorpat, Nr. 35, 561-598.

Kotov, N. D., Nikanorova, E. A. & Nikanorov, J. I. 1958. Fisheries research in lakes of Latvian SSR [Рыбохозяйственные исследования озер Латвийской ССР]. Fisheries in inland waters of the Latvian SSR, Issue 2. Riga, 259-292. (In Russian)

Kottelat, M. & Freyhof, J. 2007. Handbook of European freshwater fishes. Cornol & Berlin: Kottelat & Freyhof, Berlin, 646 p.

Lablaika, I. 1961. Burtnieku ezera zivis, to bioloģija un nozvejas [The fishes of lake Burtnieks, those biology and catches]. Pētera Stučkas Latvijas valsts universitātes zinātniskie raksti. 39. sējums. Rīga, 47-111. (In Latvian)

Laganovska, R. 1957. Latvijas PSR ezeru repsis – *Coregonus albula* (L.) un tā bioloģija [The vendace *Coregonus albula* (L.) and its biology in lakes of Latvian SSR]. Latvijas PSR Zinātņu akadēmijas vēstis 3, 116, Rīga, 83-96. (In Latvian)

Leinerte, M. 1988. Ezeri deg [Lakes in fire]. Rīga, 94. lpp. (In Latvian)

Mannsfeld, W. 1930. Studien an Coregonen des Ostbaltikums. Archiv Fur Hydrobiologie 21: 65-94.

Mansfelds, V. 1936. Latvijas zivis [Fishes of Latvia]. Latvijas zeme, daba un tauta. II. Rīga, 490-519. (In Latvian)

Nikanorov, J. I. 1960. About seasonal distribution of vendace in lakes of Latvian SSR [О сезонном распределении ряпушки в озерах Латвийской ССР]. Fisheries in inland waters of the Latvian SSR, Issue 5. Riga, 69-84. (In Russian)

Nikanorov, J. I. 1962. Biological heterogeneity and fisheries indices of European vendace in lakes of Latvian SSR [Важнейшие промысловые показатели внутревидовой биологической неоднородности европейской ряпушки в озерах Латвийской ССР]. Biology of inland waters in Baltic, 120-127. (In Russian)

Nikanorov, J. I. 1964. Morphologic peculiarity of local stocks of *Coregonus albula* depending on living conditions [Морфологические особенности локальных стад европейской ряпушки *Coregonus albula* в зависимости от условий обитания]. Questions of Ichthyology, Tome 4, Issue 3, 32: 411-422. (In Russian)

Oreha, J. & Škute, N. 2009. Morphological characteristics of local populations of European vendace *Coregonus albula* (L.) in some lakes of Latvia during 50 years. Proceedings of the Latvian Academy of Sciences. Section B, 63, 6: 271-278.

Per, F. L. 1968. The living conditions of vendace in lakes of Latgales highland [Условия обитания ряпушки в озерах Латгальской

возвышенности]. Materials of the XIV Conference of studying of inland reservoirs of the Baltic Republics. Part 1, Riga, 99-102. (In Russian)

Plikšs, M. & Aleksejevs, Ē. 1998. Zivis [Fishes]. Rīga, 304. lpp. (In Latvian)

Reshetnikov, J. S. 1980. Ecology and systematics of coregonids [Экология и систематика сиговых рыб]. Moscow, Nauka, 300 p. (In Russian)

Shaposhnikova, G. X. 1971. The comparative- morfological description of whitfishes family *Coregonus* in the Lake Sevan [Сравнительно-морфологическое описание сигов рода *Coregonus* оз. Севан]. Questions of Ichthyology, Tome 11, Issue 4, 69: 575-586. (In Russian)

Sloka, N., 1961. Materiāli par Vidzemes centrālās augstienes lielāko ezeru – Alauksta, Ineša, Kāla, Kaķīša – hidrobioloģiju [Materials on Vidzeme highland lakes - Alauksta, Ineša, Kāla, Kaķīša – hydrobiology]. Pētera Stučkas Latvijas valsts universitātes zinātniskie raksti. 36. sējums. Rīga, 153-196. (In Latvian)

Vadzis, D. R., Dzene, I. J., Kachalova, O. L. & Sloka, J. J. 1967. The feeding of fishes in mesotrophic lakes of Latvian SSR (on lake Ilzas-Geraņimovas example) [Особенности питания риб в мезотрофных водоемах Латвийской ССР (на примере оз. Илзас-Геранимовас)]. Academy of Sciences of Latvian SSR 9, 242: 100-112. (In Russian)

Vadzis, D. R., Dzene, I. J., Kachalova, O. L. & Sloka, J. J. 1967. The feeding of fish and their food resources relationship, fisheries perspectives in lake Rušons [Особенности питания рыб в связи с кормовой базой и рибохозяйственные переспективы озера Рушону]. Academy of Sciences of Latvian SSR 4, 249: 68-80. (In Russian)