

# DISTRIBUTION OF FRESHWATER CRAYFISH IN LATVIA

Ēriks Aleksejevs, Jānis Birzaks

Aleksejevs Ē., Birzaks J. 2020. Distribution of freshwater crayfish in Latvia. *Acta Biol. Univ. Daugavp.*, 20 (1): 1 – 11.

Information about crayfish in 404 lakes, 368 rivers and 47 reservoirs in Latvia, from various sources of literature and unpublished materials, as well as from self-gathered data from fieldwork during 1988–2018, was collated and analyzed. The occurrence and distribution of native and alien species of crayfish in Latvia, from the 1930s until today, has been described.

The history of invasive alien species was analyzed and the existence of populations of 4 crayfish species (the noble crayfish – *Astacus astacus* (Linnaeus, 1758), the narrow-clawed crayfish – *Astacus leptodactylus* (Eschscholtz, 1823), the signal crayfish – *Pacifastacus leniusculus* (Dana, 1852) and the spiny-cheek crayfish – *Orconectes limosus* (Rafinesque, 1817)) that are found in Latvia was evaluated, as was their future distribution.

Key words: Latvia, freshwater crayfish species, distribution.

Ēriks Aleksejevs. Fish Resource Research Department, Institute of Food Safety, Animal Health and Environment "BIOR", Daugavgrīvas Street 8, Riga, LV-1048, Latvia, E-mail: eriks.aleksejevs@bior.lv

Jānis Birzaks. Daugavpils University, Institute of Life Sciences and Technology, Vientības Street 13, Daugavpils LV- 5401, Latvia, E-mail: janis.birzaks@du.lv

## INTRODUCTION

The first mention of species of crayfish that are found in Latvia, and their approximate distribution, was noticed in an article on the Latvian nature (Bērziņš 1936). A significant reduction in crayfish stocks was noted, caused by crayfish diseases, the straightening of rivers and dredging, and in some places, by overfishing (Kalniņš 1939). The occurrence of crayfish and the condition of stocks was also evaluated in the same way, in the 1950s (Mazītis 1955).

The inspection of 549 Latvian lake fisheries was undertaken from 1951 to 1956, and also included an evaluation of the presence of crayfish (Kotov et al. 1958).

The first specialized crayfish surveys took place from 1962 to 1968, when employees from the Institute of Biology surveyed 80 lakes (Jurane 1967, Jurane & Dzene 1969).

Up until the 1980s, ichthyologists from the Baltic Fish Conservation and Reproduction Administration, as well as employees from the Latvian Institute of Livestock Farming and Veterinary Scientific Research were involved in the evaluation of crayfish stocks in separate lakes, but the Inland Waters Laboratory (Aleksejevs 2006), which is currently a BIOR structural unit, since 1992. Information about the occurrence of crayfish has been collected at the Inland Waters Laboratory since 1988, when crayfish were found as bycatch in fishing gear (nets and beach seine) meant for catching fish.

The Inland Waters Laboratory collaborated with the Latvian Crayfish and Fish Breeders Association from 2002 until 2004 in the surveying of crayfish stocks in 69 lakes (Taugbøl at al. 2004, Arens & Taugbøl 2005).

The goal of the surveys was to collate the information about the occurrence and distribution of crayfish in Latvia's inland waters that was available in the literature and archival materials, with the data that was obtained in surveys that they undertook themselves.

## **MATERIALS AND METHODS**

The evaluation of the occurrence and distribution of crayfish stocks was undertaken from 1992 to 2018, in various seasons from April to November, using cylindrical traps with two entrances. The length of the traps was 55 cm, the diameter was 30 cm, and the mesh size was 10 mm. The traps were placed mainly in the coastal zone of lakes in linear lines of 5 traps with a distance between the traps of 5 meters. They were placed in the water in the evening prior to the onset of darkness and removed at sunrise. Fresh cyprinids which came from the same body of water where the crayfish were caught were used as bait. Roach and bream were often used, with rudd, silver bream, bleak and tench used more rarely.

Five to twenty traps were usually used in test fishing to establish the presence of crayfish, depending on the size of the lake and its suitability, but in individual cases, the number of traps was increased to 120.

Additional information about the occurrence of crayfish in lakes and reservoirs was obtained using a fish fry beach seine (opening of 10 m and mesh size cod-end – 5 mm). In several lakes, the crayfish were also caught with nets used in fishing.

Crayfish in rivers were mainly found during fish monitoring which was undertaken using an electro-fishing device.

In the period from 1992, surveys in which there was a possibility of finding crayfish were

undertaken in 404 (20% of their total) lakes, in 35 (7%) reservoirs on rivers, in 9 (13%) quarry reservoirs and in 368 (3%) rivers.

There were 14,573 crayfish in total caught during 523 test fishing sessions in 334 lakes, 32 reservoirs on rivers, 12 quarry reservoirs and 5 rivers, in which crayfish traps were also used in fishing. In individual cases (42 of 230, or 18% of test fishing sessions) when crayfish were not caught in traps, they were established as bycatch in other fishing equipment. Crayfish were also caught in this way in 29 test fishing sessions, in which crayfish traps were not used at all. There were 584 crayfish caught at 2,003 sample sites in 368 rivers where fishing took place using an electro-fishing device.

## **RESULTS AND DISCUSSION**

### **Distribution of crayfish in Latvia**

Crayfish have been found in many Latvian lakes and rivers in the 1930s (Bērziņš 1936), but their numbers were not specified.

In fisheries assessments of 549 Latvian lakes undertaken by the Baltic Fish Conservation and Reproduction Administration from 1951 to 1956, which also included an evaluation of crayfish stocks, their occurrence was noted in 241 lakes, or 40% of the total number of lakes surveyed (Kotov et al. 1958). From supplementing this information with an analysis of archival data and including catch statistical data about individual lakes as well, the conclusion can be made that crayfish could be found in 273 or 50% of the lakes surveyed in the 1950s. However, there is no data about the species of crayfish in these sources of information.

The species of crayfish were also identified in the first surveys undertaken specifically on crayfish by employees of the Biology Institute from 1962 to 1968, when 80 lakes were surveyed (Jurane 1967, Jurane & Dzene 1969). Crayfish were mentioned as having been found in 34 lakes. A questioning of local residents was also conducted in parallel. The presence of crayfish could be attributed to 163 lakes and 109 rivers in Latvia from the data in this survey.

In the period from 1969 to 1989, some limited information about the occurrence of crayfish in 68 lakes was contained in unpublished archive materials at the Baltic Fish Conservation and Reproduction Administration.

Surveys of crayfish undertaken by the Inland Waters Laboratory from 1992 to 2018 found their presence in 190 lakes, 10 reservoirs on rivers, 7 quarry reservoirs and 78 rivers.

Therefore, from 1951 to 2018, using a variety of sources of information, crayfish were found in 566 lakes, 49 reservoirs on rivers, 24 quarry reservoirs and 211 rivers in total (Fig.1.).

Additional information is available about lakes that are 10 hectares in area or larger. Crayfish were ascribed to 492 or 65% of the 757 lakes of this size. Taking into account water quality and the direct connection with other waters where crayfish can be found, their occurrence could be predicted in about 594 or 78% of these lakes. Approximately 1,200 lakes are from 1.0 to 9.9 hectares in Latvia. Crayfish are mentioned as having been found in only 74 or 6% of the total number of these lakes. The assumption is that this has been determined mainly due to a lack

of information, especially in cases, when the number of specimens in the population is small.

As for rivers with a length of 10 km and greater, crayfish have been ascribed to 140 or 19% of the 750 rivers of this size. The occurrence of crayfish has also been mentioned in 42 smaller rivers, which is less than 1% of their total number.

Crayfish were ascribed to 38 reservoirs or approximately 6% of 600 reservoirs, where the water surface area was greater than or equal to 1 hectare, as well as 16, or approximately 16%, of 100 quarry reservoirs of this size.

The existence of the crayfish population in specific reservoirs is quite inconsistent, which is determined by their, more or less, regular mass mortality mainly as a result of disease, as well as their release.

Mass mortality of crayfish in Latvia's inland waters has been mentioned at least since 1900 in the Gauja River (Dogel 1989). Crayfish imported from Central Europe were released into this river's tributaries in 1893 (Mazītis 1955), which, may possibly have been the original

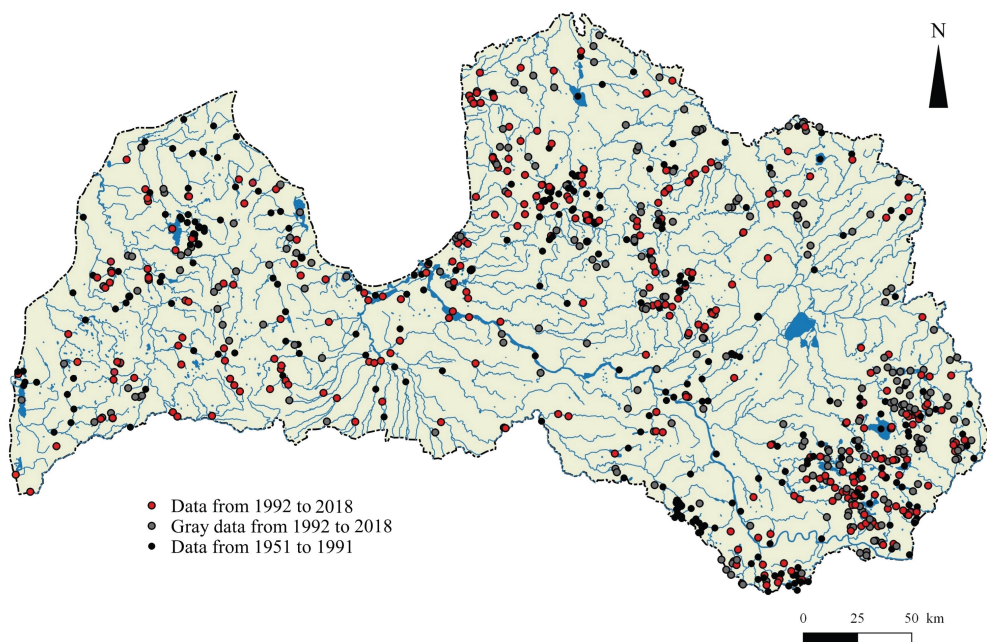


Fig. 1. Distribution of crayfish in Latvia (1951-2018).

source of the spread of the crayfish plague in Latvian waters. Judging from local literature sources, the crayfish plague in Latvia's inland waters, had already been noted in 1909, and in a larger scale from 1935 to 1937 (Mazītis 1955). A mass mortality of crayfish was also observed in individual lakes in 1966 and 1967 (Grapmane & Kaire 1968). Overall, the mass mortality of crayfish has been mentioned in 119 lakes and 11 rivers up until today. In the majority of cases (at least 96 lakes), it took place in the period up to 1952. There were no cases observed in the 1970s and 1980s, although there were individual cases when crayfish and fish died off by the use of toxic substances in agriculture.

In 1993, a mass mortality crayfish was observed in a lake, where the fish were unaffected. Since then, it has also been noted in separate lakes from 2004 to 2018, which may lead to the conclusion that in certain conditions, outbreaks of crayfish diseases are periodic and possibly connected with population density.

The transfer and release of crayfish has taken place in Latvia from at least the late 19<sup>th</sup> century. This was also done in water bodies where there was already an existing population. From 1941, crayfish were released in more than 86 lakes, but it is not known whether the widening of their distribution, the renewal of lost populations or an increase in their stocks was possible in this way. The effectiveness of this measure has not been recorded, as commercial crayfish fishing was forbidden, and the data available from recreational fishing comes only from separate lakes.

There is a possibility that in some cases the transfer and release of crayfish may have been the reason for the extinction of the local population.

Along with state sanctioned crayfish propagation projects, the illegal transfer of crayfish from one waterbody to another has also taken place, but these cases have not been officially recorded. (Aleksejevs 2006).

Overall, crayfish can be found throughout the country in all the largest river basins, and new species have been introduced into Latvia's fauna at the same time.

## Crayfish species in Latvia

Nowadays, four species of crayfish can be found in Latvia's inland waters: the noble crayfish – *Astacus astacus* (Linnaeus, 1758), the narrow-clawed crayfish – *Astacus leptodactylus* (Eschscholtz, 1823), the signal crayfish – *Pacifastacus leniusculus* (Dana, 1852) and the spiny cheek crayfish – *Orconectes limosus* (Rafinesque, 1817).

As reported in popular science publications the white-clawed crayfish *Austropotamobius pallipes* (Lereboullet, 1858) was brought in from Central Europe in 1893 and released in the waters of Vidzeme and Kurzeme and has successfully reproduced and interbred with the local noble crayfish (Mazītis 1955, 1967, 1971). The introduction of the “northern dwarf crayfish”, previously called the stone crayfish *Astacus torrentium* (Schrank, 1803), from Scandinavia, and its release into the rivers and lakes of northern Latvia also took place a little earlier (Mazītis 1955, 1967, 1971).

Another article mentions the introduction of the stone crayfish into Latvia (Sprūzs 2004, quoted from Mazītis 1967). But, judging from the distribution of crayfish in Europe (Kouba at al. 2014), it seems doubtful that the species introduced into Latvian waters from Scandinavia was the stone crayfish or *Austropotamobius torrentium* (Schrank, 1803). Information about the places of origin of the introduced crayfish, its successful propagation and interbreeding with the local noble crayfish, leads one to think that the noble crayfish may possibly have been introduced into Latvia from different European countries in the late 19<sup>th</sup> century, and that the white-clawed crayfish and stone crayfish, were, most likely, never actually introduced.

The establishment and existence of populations of both species of crayfish in Latvia is nowadays unknown. These species cannot be found in Latvia's neighboring countries Estonia, Lithuania, Belarus or Russia either (Kouba at al. 2014).



**Noble crayfish *Astacus astacus* (Linnaeus, 1758)**

The noble crayfish is obviously the only local species in Latvian waters. It has been found in many lakes and rivers throughout the territory of Latvia (Bērziņš 1936, Mazītis 1955, 1967, 1971).

In surveys undertaken from 1962 to 1968 (Jurane 1967, Jurane & Dzene 1969), 31 lakes where noble crayfish could be found were mentioned. These lakes were distributed fairly evenly throughout the territory of Latvia.

In parallel to this, a survey of local fishermen was undertaken via questionnaires. From the collated data, crayfish were ascribed to 163 lakes and 109 rivers in Latvia. From the sites indicated on the map included in the publication (Jurane 1967), noble crayfish could be found in 95% of them, with narrow-clawed crayfish in the rest.

Judging from the Baltic Fish Conservation and Reproduction Administration's archival materials from the 1970s and 1980s, distinguishing between the species of crayfish

has not always been correct. The local residents and crayfish fishermen's surveyed called the smaller sized noble crayfish "swamp crayfish", and the specimens with regenerated claws, as narrow-clawed crayfish. Therefore, the data from various surveys and questionnaires, as can be observed nowadays too, is not certain enough in relation to the systemic affiliation of the crayfish found in this or that water body.

In the surveys that we conducted from 1992 to 2018, noble crayfish was found in a total of 158 lakes, 52 rivers, 6 reservoirs on rivers and 5 quarry reservoirs throughout the territory of Latvia, in all of the largest river basins, (Fig. 2.).

In general, a trend can be observed, that the occurrence and local distribution of noble crayfish is decreasing, which is caused by their periodical mass mortality, and the increased distribution and occurrence of other species of crayfish.

In neighboring Estonia, noble crayfish are the only local species (Paaver & Hurt 2010, Kouba et al. 2014). Similarly, in Lithuania too, it is considered to be the only local crayfish species (Burba 1994, Taugbøl 1998, Arbačiauskas et al.

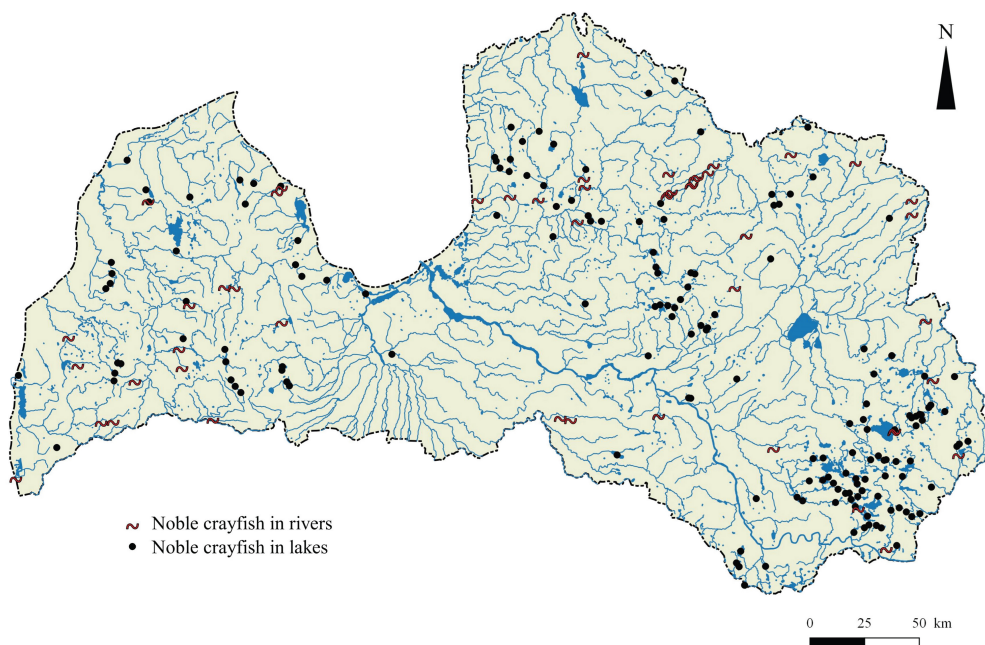


Fig. 2. Distribution of noble crayfish in Latvia (1992-2018).

2012). In Belarus, the noble crayfish populations have co-existed with narrow-clawed crayfish (Šteinfeld 1957, Aklehnovich & Razlutskiĭ 2013).

### Narrow-clawed crayfish *Astacus leptodactylus* (Eschscholtz, 1823)

The distribution of narrow-clawed crayfish is mainly linked with the south-eastern region of the country and more rarely in the rest of Latvia (Bērziņš 1936, Mazītis 1955, 1967, 1971).

Earlier evaluations of the distribution of this species have been quite inconsistent. Thus, in one of the publications, where survey data has also been used, 14 sites along Latvia's southern border were mentioned (Jurane 1967). Whereas, a map in another publication (Jurane & Dzene 1969) shows 50 narrow-clawed crayfish sites, which also include the central and northern part of Latvia. Even though, the number of lakes surveyed directly, compared to prepublication, fundamentally doubled (80), this is still not mentioned as an increase in the number of sites in the text of the article, but is portrayed graphically on the map. It shows that narrow-clawed crayfish can be found mainly

in the southern part of Latvia and 3 lakes are mentioned in which they can be found in large numbers.

In the most recent surveys from 1992 to 2018, narrow-clawed crayfish were found in 33 lakes, 4 rivers, 3 reservoirs on rivers and 2 quarry reservoirs (Fig. 3.).

Of the largest rivers, individual examples were found only in the Lielupe, but were also encountered in reservoirs in the Daugava and Gauja rivers basins.

The early origin of the narrow-clawed crayfish in Latvia is unclear. In the literature (Bērziņš 1936, Mazītis 1955, 1967, 1971) the presence of species is mentioned early in the previous century, without mention of it as having developed as a result of their introduction.

In later publications (Jurane 1967, Jurane & Dzene 1969), the assumption that narrow-clawed crayfish were brought into Latvia from Belarus or Lithuania was expressed, but no specific facts were mentioned. This may be why it tends to be described as being a local species in all three neighboring countries (Holdich

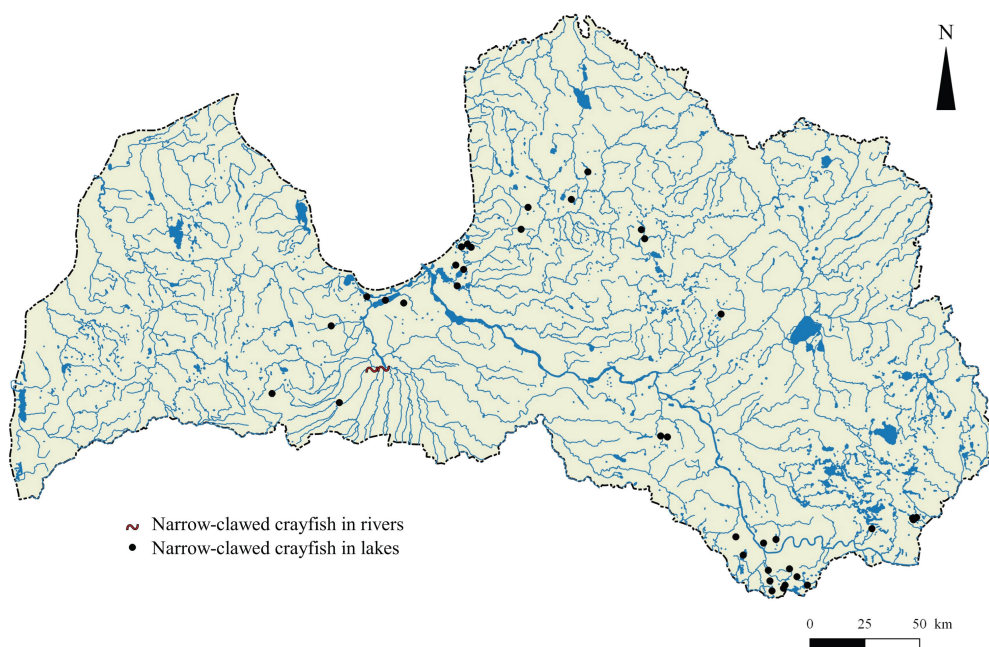


Fig. 3. Distribution of narrow-clawed crayfish in Latvia (1992-2018).

2002), or even mentioned as a local European species which has been introduced into Latvia and Lithuania relatively recently (Holdich et al. 2009).

The assumption that it was introduced into Lithuania from Latvia or Belarus in the late 19<sup>th</sup> century has also been expressed (Burba 1994).

In the Pskov region of Russia which borders Latvia, narrow-clawed crayfish, which were introduced from Belarus, can only be found in a few lakes and rivers (Rahmanov 1976).

In Belarus, narrow-clawed crayfish are considered to be a local species with its area of distribution having increased in a northerly and north-westerly direction (Steinfeld 1957, Aklehnovich & Razlutsij 2013).

The greatest number of narrow-clawed crayfish populations in Latvia is in the south and southeast part of the country in the border zone with neighboring countries Lithuania and Belarus. The character of its distribution leads to the assumption that, historically, narrow-clawed crayfish have not been a local species in Latvia. At the same time, the distribution of narrow-

clawed crayfish in neighboring countries (Arbačiauskas et al. 2012, Kouba et al. 2014) provides evidence, that the artificial spread of its natural habitat to Latvia has, in actual fact, taken place.

Narrow-clawed crayfish have not been found further to the north of Latvia and in Estonia (Paaver & Hurt 2010, Kouba et al. 2014).

Compared to the first half of the previous century, there has been an increase in their occurrence and distribution, caused by their illegal introduction from Belarus into individual lakes in the northeastern part of Latvia in the 1980s. From unofficial information, the unsanctioned spread of narrow-clawed crayfish is taking place nowadays too. However, a particularly rapid increase in their occurrence and distribution will not, most likely take place. Just like the noble crayfish, mass mortality is characteristic to this species and was observed in four lakes from 1993 to 2010. The narrow-clawed crayfish may possibly lose in competition with the spiny cheek crayfish, the distribution area of which is rapidly increasing. Thus, 212 spiny cheek crayfish and only one narrow-clawed crayfish were caught during test fishing at 5 sites in a

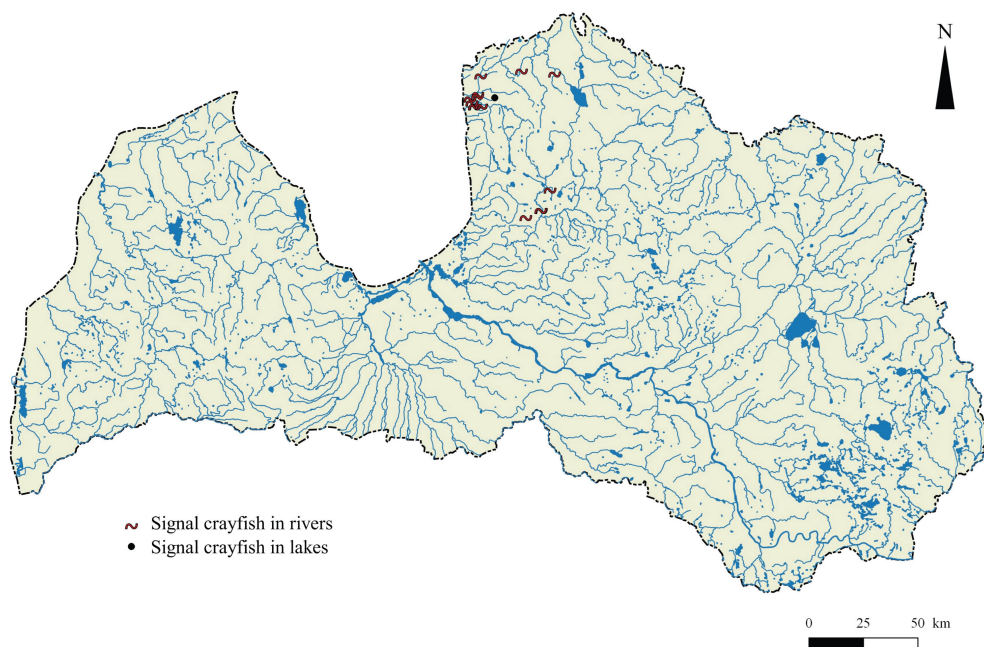


Fig. 4. Distribution of signal crayfish in Latvia (1992-2018).

25 km long section of the Lielupe in 2005 and 2006.

### Signal crayfish *Pacifastacus leniusculus* (Dana, 1852)

Signal crayfish were introduced into Latvia from Lithuania in 1983 and 1984 and released into Primmas Lake in 1983-1985 (Mjasischev 1991). They were raised in a fish farm on the Gauja's tributary, the Brasla, from which it entered this river.

The signal crayfish have successfully acclimatized and formed a naturally reproducing population in Primmas Lake. The signal crayfish may possibly have reached the adjacent Kliķu Lake via the ditch system and along the Korge River into the Salaca River and the rivers in its basin, where a particularly large population of signal crayfish has developed.

In total, signal crayfish were found in one lake and 9 rivers from 1992 to 2018, where, according to unofficial information, they ended up mainly as a result of their unsanctioned spread from a fish farm, where they were bred, or from the lake where they acclimatized. (Fig. 4).

Their legal catching in the Salaca River, which commenced in 2007, has obviously facilitated this process even more.

Up till now, they have been found in natural water bodies only in the Salaca and Gauja rivers basins, but from unofficial information they were also released in the Daugava River basin, as well as in 2 small rivers flowing into the Gulf of Riga. The species is bred artificially in fish farms and introduced into artificial water bodies. The signal crayfish, an alien species, the natural area of distribution of which is not associated with Europe, is considered to be an invasive species in Latvia. Its further distribution in lakes has not been observed, but its presence in rivers is linked to the river basins of the Salaca and the Gauja.

Bearing in mind that the mass mortality of the signal crayfish, as opposed to the noble and narrow-clawed crayfish, has not been observed in Latvia, managers of individual natural waters are interested in their illegal introduction, which will obviously gradually increase their distribution area.

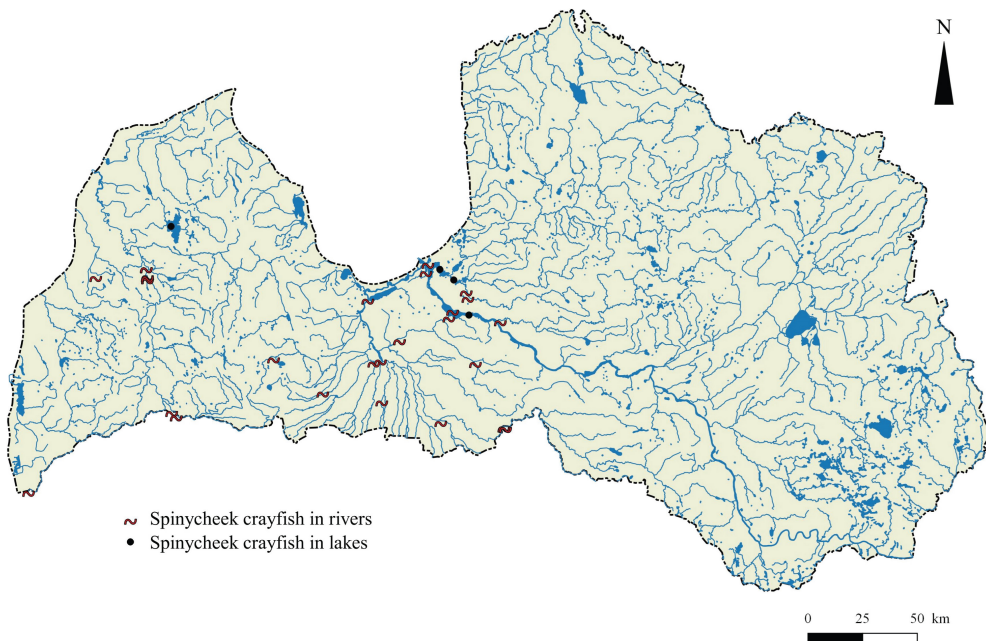


Fig. 5. Distribution of spiny-cheek crayfish in Latvia (2005-2018).



### **Spiny cheek crayfish *Orconectes limosus* (Rafinesque, 1817)**

It was recognized as a new species of crayfish in Latvia for the first time in 2005, in the Lielupe River. Up until 2018, it has been caught during test fishing in 3 lakes, 13 rivers and 2 quarry reservoirs (Fig. 5.).

From unofficial information, it has been found in Latvia from at least the 1990s. The entry of the spiny cheek crayfish into Latvia is unclear. It can be found in the Daugava River, as well as the Sventāja and the Venta rivers and the Lielupe River tributaries, the Mēmele and the Mūsa rivers, which originate in Lithuanian territory. The spiny cheek crayfish can also be found in Lithuania, in the upper reaches of the rivers of the Lielupe basin and the Venta River (Arbačiauskas et al. 2012), from where it may possibly have migrated to Latvian territory.

The spiny cheek crayfish, an alien species, the natural distribution area of which is not connected with Europe, is considered to be an invasive species in Latvia.

It can be seen from fish monitoring in rivers that the number of the individual sites where spiny cheek crayfish were found in rivers has been increasing in recent years. Thus, in 2005, one individual site was found in the Lielupe River, but 18 individual sites in total were found in 2015 and 2016 in 8 rivers.

From 2006 to 2015, the spiny cheek crayfish was found in 2 lakes connected to the lower reaches of the Daugava River, but in 2016, it was found in Lake Usmas, which is located inland and is not connected with the river basins in which it has been found up till now. Its rapid spread has been observed in the Venta River, where it was found for the first time near the Lithuanian border in 2011, but it could already be found in a 123 km long section in 2016. The spiny cheek crayfish can be found in the Sventāja, a river which flows along the Latvian–Lithuanian border. Overall, the impression arises, that the spiny cheek crayfish is spreading rapidly in the waters between the basins of the Venta and the Daugava Rivers, in fact, in three of the four Latvian river basin districts.

Since 2013, its legal catching has been permitted in unlimited numbers in the lower reaches of the Daugava, the Lielupe and the Venta Rivers, which will probably facilitate the unsanctioned dissemination process of the spiny cheek crayfish even more. From unverified information, it can be found in the south-eastern part of Latvia as well, but it has not been attributed to the waters of the Daugava River basin in Belarus (Aklehnovich & Razlutskijs 2013).

## **CONCLUSIONS**

From the information available in the literature and in archives about specific crayfish individual sites in Latvia in the period from the 1930s until the 1980s, they cannot usually be ascribed to specific species, as in many cases they were not defined or defined incorrectly.

Various information sources reveal that, up until the present, the presence of crayfish has been mentioned in 566 lakes, 73 reservoirs and 211 rivers in total.

Four species of crayfish can be found in Latvia's inland waters: the noble crayfish, narrow-clawed crayfish, signal crayfish and the spiny cheek crayfish. Even though the literature mentions that 3 other alien species were introduced into Latvia in the 19<sup>th</sup> century, they have not been established up till now.

The noble crayfish is obviously the only local species of crayfish. It has been established as existing in 158 lakes, 11 reservoirs and 52 rivers. A trend has been observed for a decreasing presence and local distribution of the noble crayfish.

The narrow-clawed crayfish has been encountered in Latvia since at least the 1930s. It has been encountered in 33 lakes, 5 reservoirs and 3 rivers. A small increase in the presence and distribution of the narrow-clawed crayfish has been observed, which, judging from the locations where populations of it can be found, indicates its unsanctioned distribution.

The signal crayfish, which was introduced into Latvia in 1983 for economic purposes, is nowadays considered to be an invasive species.

It has been found in one lake and 9 rivers. The occurrence and distribution of the signal crayfish is slowly increasing.

The spiny cheek crayfish was found in Latvia for the first time in 2005. The nature of its occurrence and distribution shows that the species has entered Latvia as a result of migration along rivers, but it has been spread in an unsanctioned way in individual cases. The occurrence and distribution of the spiny cheek crayfish is rapidly increasing, and it has been found in 3 lakes, 2 reservoirs and 13 rivers.

The increasing occurrence and distribution of invasive species, and of the narrow-clawed crayfish, is connected mainly with their unsanctioned distribution and propagation.

## REFERENCES

- Aleksejevs Ē. 2006. Latvian crayfish. Latvian fisheries yearbook 2006. 10th year. Pp. 73-81 (in Latvian).
- Aklehnovich A. and Razlutskiĵ V. 2013. Distribution and spread of spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) in Belarus. *BioInvasions Records*, 2 (3): 221-225.
- Arbačiauskas K., Višinskiene G., Smilgevičiene S. and Rakauskas V. 2012. Non-indigenous macroinvertebrate species in Lithuanian fresh waters, Part 1: Distributions, dispersal and future. *Knowl Manag Aquat Ecosyst.*, 402: 1-18.
- Arens A., and Taugbøl T. 2005. Status of freshwater crayfish in Latvia. *Bull Fr Pêche Piscic*, 376 -377: 519-528.
- Bērziņš B. 1936. Latvian crayfish. In: Malta N., Galeniĵs P., ed. Latvian land, natura and people. 2. Latvian nature. Rīga. Pp. 624-630 (in Latvian).
- Burba A. 1994. Facts about Crayfish in Lithuania. *Nordic J. Freshw. Res.*, 69: 170-172.
- Dogel V.A. 1989. Crayfish plague (historical review). State of natural resources, reproduction and commercial breeding of river crayfish. *GOSNIORH*, 300: 124-136 (in Russian).
- Grapmane L.K. and Kaire L.D. 1968. The infectious diseases of crayfish *Astacus astacus* in lakes and rivers of Latvian SSR. *Proceedings of a XIV conference on research of Baltic inland waters*, 2 (2): 24-26. (in Russian).
- Holdich D.M. 2002. Distribution of crayfish in Europe and some adjoining countries. *Bull Fr Pêche. Piscic.*, 367: 611-650.
- Holdich D.M., Reynolds J.D., Souty-Grosset C. and Sibley P.J. 2009. A review of the ever increasing threat to European crayfish from non-indigenous crayfish species. *Knowl. Manag. Aquat. Ecosyst.*, 394-395: 11.
- Jurane A.D. 1967. Distribution of River crayfish and its stocks in water bodies of Latvian SSR. Resources of North-West inland waters. *Proceedings of Karelian department of GOSNIORH*, 5 (1): 219-223 (in Russian).
- Jurane A.D. and Dzene I.J. 1969. Distribution of river crayfish and its stocks in water bodies of Latvian SSR. *Proceedings of a XIV conference of investigations of Baltic inland waters*, 51-55 (in Russian).
- Kalniņš J. 1939. Crayfish breeding and catch. *Fisheries Monthly.*, 6: 351-253 (in Latvian).
- Kouba A., Petrussek A. and Kozák P. 2014. Continental-wide distribution of crayfish species in Europe: update and maps. *Knowl. Manag. Aquat. Ecosyst.*, 413: 1-31.
- Kotov N. D., Nikanorova J.A. and Nikanorov J.I. 1958. Lakes fishery research of the Latvian SSR. Latvian SSR inland waters fisheries. *Proceedings of the Latvian Academy of Sciences* 2: 259-292 (in Russian).
- Mazītis Z. 1955. Crayfish breeding in Latvian SSR freshwater. Rīga. Pp. 42 (in Latvian).

Mazītis Z. 1967. Crayfish and breeding of them. Rīga, 35 p. (in Latvian).

Received: 01.02.2020.

Accepted: 10.07.2020.

Mazītis Z. 1971. Selection and industrial breeding of crayfish. Rīga. Pp. 70 (in Latvian).

Mjasischev E.V. 1991. Acclimatization and experience of farming of American signal crayfish. In: Kalejs M. et. al. *Acquaculture in Baltic*. Rīga. Pp. 100-108 (in Russian).

Pastors A. 1988. As rich we are. In: O.Gerts ed. *Nature and history calendar for 1989*. Riga. Pp. 73-78. (in Latvian).

Paaver T. and Hurt M. 2010. Status and management of noble crayfish *Astacus astacus* in Estonia. *Knowl. Manag. Aquat. Ecosyst.*, 394-395: 18.

Rahmanov V.R. 1976. Biology and fishery of river crayfish in BSSR. Resources of inland waters of Pskov region. *Proceedings of the Pskov's department of GOSNIORH*, 5(2): 121-145 (in Russian).

Sprūžs J. 2004. Crayfish breeding. Jelgava. Pp. 37 (in Latvian).

Taugbøl T., Skurdal J. and Burba A. 1998. Freshwater crayfish in Lithuania. I: *Action plan for crayfish management*. II: *Crayfish status. report. Østlandsforskning, rapport*. 12: 83.

Taugbøl T., Arens A. and Mitans A. 2004. Freshwater Crayfish in Latvia: Status and Recommendations for Conservation and Sustainable Use. *Norwegian Institute for Nature Research, Latvian Crayfish and Fish Farmers Association and Latvian Fisheries Research Institute, NINA Project Report*, 29: 23.

Šteinfeld L.A. 1957. Biology and fishery of river crayfish in BSSR. *Proceedings of Belorussian department of VNIORH* 5(1): 118-137 (in Russian).