Distribution of non-indigenous crayfish species in Estonia and their threat to noble crayfish (*Astacus astacus* L.) populations

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INTRODUCTION

The noble crayfish (*Astacus astacus*) is the most highly valued freshwater crayfish species in northern Europe. Once abundant, it has suffered from a long-term population decline due to introduced non-indigenous crayfish species (NICS), crayfish plague, habitat loss and over-harvesting, and is now considered threatened. Until 2008, Estonia was one of the last countries in Europe where NICS were not recorded. Today, three alien crayfish species have been detected, which threaten *A.astacus* populations. In Estonia, the noble crayfish occurs in more than 300 lakes and stretches of river, but mostly at low densities, except for some populations in South-Eastern Estonia and on the island of Saaremaa (Fig. 1) (Hurt 2020). NICS are more aggressive, more fertile and more tolerant to environmental changes than indigenous crayfish species (ICS), but their most devastating effect on ICS stocks is the fact that they are latent carriers of the crayfish plague, which is caused by the oomycete *Aphanomyces astaci*.

This study gives an overview of the status, distribution, and impact on noble crayfish populations of signal crayfish (*Pacifastacus leniusculus*), spiny-cheek crayfish (*Faxonius limosus*), and marbled crayfish (*Procambarus virginalis*) in Estonia. Also, possible eradication plans are discussed.

Noble crayfish
Astacus astacus

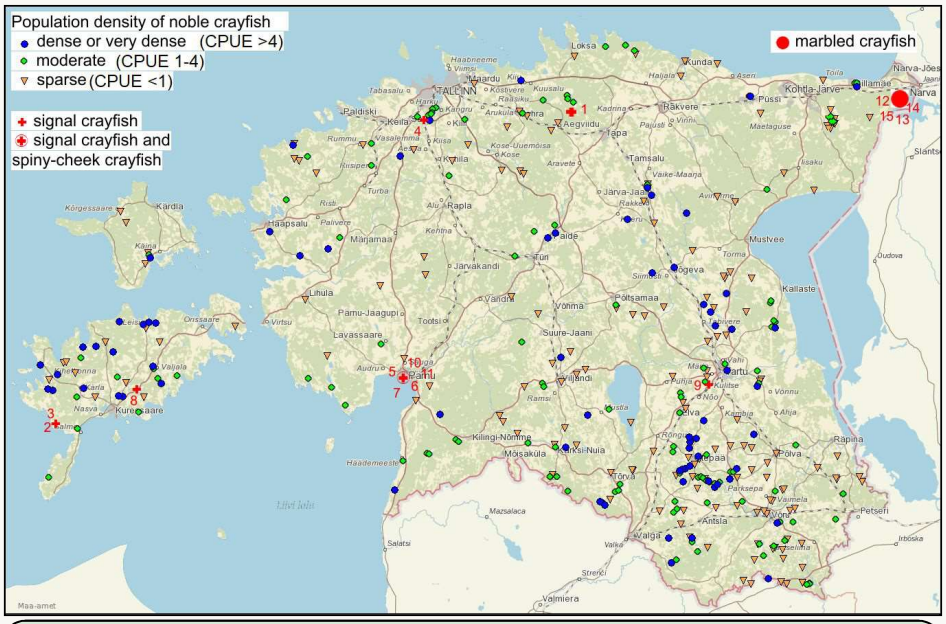


Figure 1. Distribution map of noble crayfish in Estonia. Numbers represent the locations of NICS populations - signal crayfish (1-9), spiny-cheek crayfish (5, 10 and 11), and marbled crayfish (12-15).

MATERIAL AND METHODS

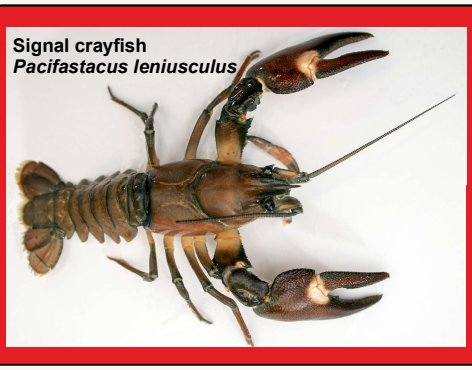
Most NICS have been found during the annual monitoring of noble crayfish. After the initial discovery of NICS, annual monitoring was continued at these sites. Test fishings were carried out by the Estonian Univesity of Life Sciences using traps (9-15 mm mesh size). Frozen fish was used as bait. Traps were applied as lines every 10 meters and kept overnight. For every trapping session capture per unit effort (CPUE) was recorded at each site. All crayfish were measured and weighed.

CONCLUSIONS

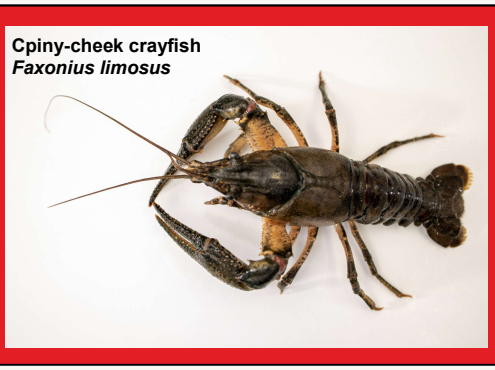
Since 2008 NICS have been recorded at 15 water bodies in Estonia and have caused the extinction of two noble crayfish populations. The dynamics of populations of NICS have been very different. The abundance of signal crayfish has fluctuated over the years. The spiny-cheek and marbled crayfish populations are much more widespread in their localities and large specimens in catches show that they are well adapted to the Estonian climate conditions.

The dispersed patterns of NICS spread indicates that the establishment of their populations is most probably the result of illegal human-assisted introductions. Further spread of NICS is possible into the catchment area of the two biggest Estonian rivers (Pärnu and Narva). Recreational fishing ban in populations of NICS and effective population eradication by intensive fishing by scientists should be continued. Biocide treatment could be considered in two signal crayfish populations sites, Reo Quarry and Ropka Water Reservoir. And finally, the continued efforts to raise public awareness of the devastating influence of NICS should be resumed.

Signal crayfish
Pacifastacus leniusculus



Cpiny-cheek crayfish
Faxonius limosus



Marbled crayfish
Procambarus virginalis

DETECTION OF SIGNAL CRAYFISH

The first signal crayfish was caught during the routine monitoring of noble crayfish in Mustjõgi in North Estonia in 2008 and is now found in six different locations across the country.

Mustjõgi River **(1)**. From 2008 to 2012, 14 individuals were caught (CPUE 0.1). From 2013 to 2021, no signal crayfish has been found. In 2022, one signal crayfish was caught again. In 2015 and 2016 noble crayfish were reintroduced and since then few individuals have been caught every year.

Riksu Stream **(2)**. First detection in 2010. Despite the capture of thousands of signal crayfish (CPUE up to 15.8), the distribution has expanded upstream and spread into the Koimla Stream **(3)**.

Vääna River **(4)**. First detection in 2012. The noble crayfish and signal crayfish co-inhabit the same site. Both species' population densities have been low (CPUE up to 0.5), however, since 2018 it started to increase (CPUE up to 7.1).

Pärnu River **(5)**. First detection in 2016. Population density is low (CPUE up to 0.9), but signal crayfish has spread also into the tributary of Vallikraav **(6)** and few individuals have been found in Pärnu Bay **(7)** (up to 2 km from the shore).

Reo Quarry **(8)**. First detection in 2018. Population density is low (CPUE up to 0.6). This can be a potential site for biocide treatment.

Ropka Water Reservoir **(9)**. First detection in 2018. The noble crayfish and signal crayfish co-inhabit the same site. The population densities of both species are low (CPUE up to 0.6). This can be a potential site for biocide treatment.

DETECTION OF SPINY-CHEEK CRAYFISH

The first spiny-cheek crayfish were caught during the population monitoring of signal crayfish in the pre-estuary of the Pärnu River with a catchment area of 6 800 km² in 2017.

The maximum total length of female and male *F. limosus* was 118 and 115 mm, respectively, which shows their good growth in Estonian climate conditions. After the discovery of spiny-cheek crayfish, additional test-fishings in the Pärnu River and its tributaries were carried out. The population density is moderate (CPUE up to 1.4), but spiny-cheek crayfish is much more widespread than signal crayfish and its population continues to expand upstream and to the other tributaries of the Pärnu River - Sauga River **(10)** and Reiu River **(11)**.

REFERENCES

Jõevähi (*Astacus astacus*) kaitse tegevuskava. (koost. Hurt, M.) Kinnitatud Keskkonnaameti peadirektori asetäitja 20.10.2021 käskkirjaga nr 1-1/21/192.

DETECTION OF MARBLED CRAYFISH

In September 2017, unknown species of crayfish were collected during the routine macroinvertebrates sampling from the outflow channel of the Balti Power Plant **(12)** cooling system, which enters into the Narva Water Reservoir with a catchment area of ~57 000 km². In February 2018 they were identified as marbled crayfish and additional test-fishing in May confirmed their presence. Some individuals were longer than 110 mm in total length, making them the largest marbled crayfish in the wild. In 2018, the population density was low to moderate (CPUE up to 3.0), but after the intensive operation of Power Plant, the number of marbled crayfish has decreased significantly.

In 2019, during the test-fishing in the outflow channel of Auvere Power Plant cooling system **(13)** (which is close to Narva), confirmed the presence of marbled crayfish. Population density is low (CPUE under 1.0), but the habitat conditions for the growth of the marbled crayfish population are good. Also, in 2019, marbled crayfish were caught in Narva Water Reservoir **(14)** (CPUE under 1.0), expanding its spread even further. In 2020, new marbled crayfish population was found in Narva Quarry **(15)**, where it co-inhabits with noble crayfish (CPUE under 1.0).

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