Belgian alert lists of alien aquatic & riparian plants and crayfish

Improving data flow for early detection (A1)

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RIPARIAS

Reaching Integrated and Prompt Action in Response to Invasive Alien Species

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Cover photo: Lizard's tail *Saururus cernuus*. Photo by J. Packet

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EXECUTIVE SUMMARY

An alert list of emerging freshwater aquatic and riparian plant and crayfish species was established for the LIFE RIPARIAS territory (an area covering 260.000 hectares in the Scheldt district encompassing the Dijle, Mark and Zenne river basins) by a three-step screening of alien species available on the Belgian market for ornamental purposes. It includes species with medium to very high environmental risk scores, assessed through the Harmonia$^+$ risk scoring system. The alert list consists of 10 plant species and 7 crayfish species native to various regions of the world.

Together with Invasive Alien Species (IAS) of EU concern, alert-list species will be subjected to enhanced surveillance through action C1 and will be a target for early eradication through action C2 of the LIFE RIPARIAS project. Identification sheets will be produced for all these species through action E2 to facilitate species recognition in the field.

1. Introduction

Alert lists are usually defined as lists of alien species not yet present or with very limited distribution in a certain area that pose a threat to biodiversity, and for which dedicated surveillance and monitoring are recommended to foster prompt response in the case of arrival and spread (Genovesi *et al* 2010).They are therefore essential for a preventive and proactive response towards IAS, including both early detection and rapid response.

Alert lists for alien aquatic and riparian plants and alien crayfish will be used for the training of field practitioners through action E2 (e.g. identification sheets), to increase species detection and rapid eradication all over the LIFE RIPARIAS territory. Together with the IAS of Union concern, alert-list species will be subjected to enhanced surveillance through action C1 and will be a target for early eradication through action C2.

2. Methodology

LIFE RIPARIAS alert lists for alien aquatic and riparian plants as well as alien crayfish were established with the 3-step methodology summarized in figure 1.

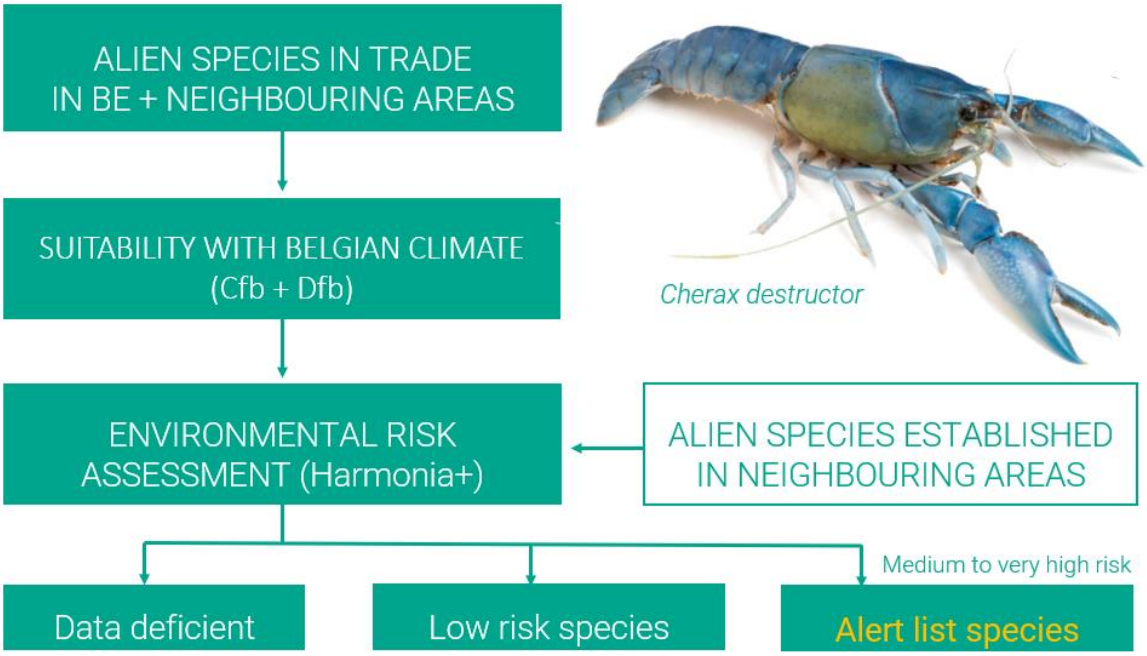

Figure 1 – The 3-step methodology used to classify alien species in different risk categories to establish the LIFE RIPARIAS alert list.

First, freshwater species available on the Belgian market (online catalogues of wholesalers, retailers and e-shops) were scanned to identify alien taxa that are still poorly established in the LIFE RIPARIAS

area and could potentially impact native biodiversity. This yielded a longlist of 203 alien plants and 40 alien crayfish currently present in the Belgian commerce.

As several taxonomic errors (e.g. generic names, synonyms, misspelling or mislabelling) can occur in plant catalogues, the identification of species was checked on the basis of a study carried out in Belgian shops by Tom Van den Neucker and Kevin Scheers (submitted) in order to determine the right identity of the plants. The most frequent mislabelling's refer to *Erythranthe guttata* (misidentified as *E. lutea*) *Gunnera tinctoria* (misidentified as *G. manicata*), *Salvinia molesta* (misidentified as *S. natans*) and *Vallisneria americana* (misidentified as *V. gigantea*). The nomenclature of plant names absent from this study was aligned with the International Plant Names Index (www.ipni.org), The Plant List (www.theplantlist.org) and KEW (https://powo.science.kew.org/).

Second, open data from the Global Biodiversity Information Facility and Köppen-Geiger climate maps (Beck *et al* 2018) were used to perform crude climate matching. Species with minimum 20 records in one or several climate classes corresponding to current climatic conditions in Belgium (Temperate oceanic climate - Cfb and Warm-summer humid continental climate - Dfb) were selected (figure 2). This resulted in a list of 152 plants and 3 crayfish able to establish in the country under current climate. One additional plant species and 5 additional crayfish species established in neighbouring areas but not reported in commercial catalogues were added to this species list based on expert judgement.

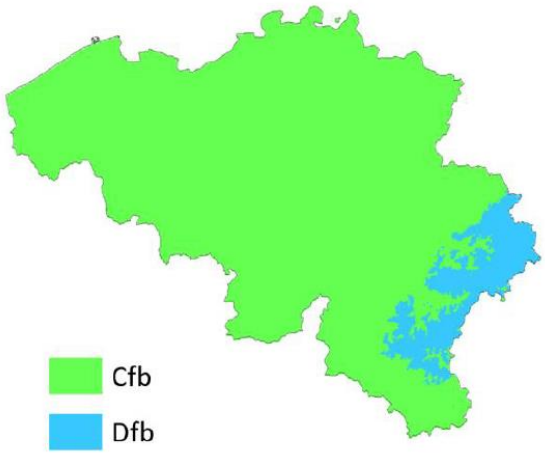

Figure 2 – Extent of Cfb (temperate oceanic climate) and Dfb (warm-summer humid continental climate) Köppen-Geiger areas in Belgium under current climatic conditions based on Beck *et al* (2018).

Third, the shortlists were subjected to environmental risk assessment using the default options of the established risk assessment scheme Harmonia⁺, i.e. considering the (arithmetic) mean of the answers provided to the different questions within each module (introduction, establishment, spread and environmental impact) and using geometric mean to combine the scores of the different modules into a global environmental risk score (D'hondt *et al* 2015). The assessment was performed by Antoine Dumortier and Etienne Branquart (plant species) and Romain Willeput and Adrien Latli (crayfish species) based on a literature review. It was conducted using the online version of the protocol which is freely available at http://ias.biodiversity.be/harmoniaplus.

The Harmonia⁺ risk scoring system yields a score between 0.0 to 1.0 for the environmental risk posed by an IAS. Scores were translated into 5 risk categories (very low, low, medium, high and very high) using the 20th, 40th, 60th and 80th percentiles of 10,000 simulations of risk scores as class boundaries (D'hondt, unpublished). All of the species falling into the medium, high and very high risk categories were ultimately considered for the alert list. Species with very low and low risk were excluded from the alert list. It should be noted that for many species, not enough ecological data and

impact studies were available to allow risk scoring with confidence. Further studies are needed to assess these species. To identify these knowledge gaps, these species were grouped into a data deficient category (Tricarico *et al* 2010, Faulkner *et al* 2014, Bayon & Vila 2019, Vilizzi *et al* 2021).

This work was undertaken in the framework of the master thesis in environmental management of Antoine Dumortier and Romain Willeput. Although result presentation is slightly adapted in the present report, general methodology and detailed results can be found in their work (Dumortier 2021 & Willeput 2021).

3. Results

3.1 Alert list of alien aquatic and riparian plants

The aquatic and riparian plant alert list consists of 9 species reported by Belgian ornamental plant catalogues and 1 additional species (i.e. *Koenigia polystachya*) not found in catalogues which are poorly established within the LIFE RIPARIAS territory and known to be invasive in neighbouring areas (table 1). This corresponds to a total of 10 species which are briefly described below. These species have an environmental risk score ranging from medium to very high, most often with a moderate confidence level (see Dumortier 2021 for details).

	Belgian status	First occurrence	Suitable climatic zones	A08 - INTRO	A09 - ESTA	A11 - SPR	A14 - COMP	Environmental risk		
								Score	Rating	CL
High and very high risk										
Crassula helmsii#	Nat.	1982	(Cfa), Cfb, (Dfb)	H	H	H	H	**0,67**	**VH**	H
Petasites japonicus	Nat.	1989	Cfa, Cfb, Dfb	H	H	L	H	**0,56**	**VH**	M
Zizania latifolia	Nat.	2010	Cfa, Cfb, Dfb	H	H	M	H	**0,35**	**VH**	M
Medium risk										
Egeria densa	Nat.	1999	Cfa, Cfb, (Dfb)	H	H	M	M	**0,23**	**M**	M
Erythranthe guttata#	Nat.	1953	Cfb, Dfb	H	H	M	M	**0,23**	**M**	H
Aponogeton distachyos	Nat.?	1993	Cfb	H	H	M	M	**0,21**	**M**	M
Houttuynia cordata	Nat.?	2010	Cfa, Cfb, Dfb	H	H	M	M	**0,21**	**M**	M
Saururus cernuus	Nat.	1977	Cfa,(Cfb), Dfb	H	H	M	M	**0,21**	**M**	M
Koenigia polystachya	Nat.	1898	Cfb, Dfb	M	H	L	M	**0,20**	**M**	M
Pontederia cordata	Nat.?	1985	Cfa, Cfb, Dfb	H	H	L	M	**0,20**	**M**	M

Table 1 – Occurrence, Belgian status, climatic zones suitable for establishment, environmental risk scores and confidence levels (CL) of the aquatic and riparian plant species included in the LIFE RIPARIAS alert list based on the Harmonia+ risk assessment protocol (D'hondt *et al* 2015). Abbreviations: Nat(uralised), intro(duction), esta(blishment), spr(ead) and comp(etition). Ratings: L (low), M (medium), H (high) and VH (very high). Climatic zones are described in figure 2. Species widely established in Belgium but poorly naturalised in the LIFE RIPARIAS territory are identified by #.

1/ **Australian swamp stonecrop *Crassula helmsii***. This amphibious plant is native to Australia and New Zealand and has established itself as an exotic invasive in many parts of Europe (Branquart *et al* 2013a, Nault & Varia 2018). It can take on various growth forms depending on prevailing conditions and can grow as a submerged, emergent, or semi-terrestrial species. It can form dense stands of 100% cover which cause many negative environmental impacts (Robert *et al* 2013). *Crassula helmsii* is extremely difficult and costly to control and its ability to form new plants vegetatively from small fragments as well as from seeds facilitates its spread to new locations *(Denys et al 2014, D'hondt et al* 2016). In recent years however, much management guidance has been developed (Scheers *et al* 2020 & 2021; Van der Loop et al. *in press*). Although it is already well established in a large part of Belgium (Scheers *et al* 2020), this plant is still poorly established within the LIFE RIPARIAS territory. This species should have been removed from most ornamental plant catalogues in Belgium since the elaboration of the LIFE ALTERIAS code of conduct (Halford *et al* 2014), yet it is often still present as a contaminant in between other plants.

2/ **Giant butterbur *Petasites japonicus***. This riparian plant usually establishes from garden waste in shaded riparian areas. In Belgium, only male specimens are observed. No seed reproduction occurs and giant butterbur spreads vegetatively through rhizome fragmentation. It can form extensive and dense stands that displace original vegetation (Lecron 2010). It is native to Japan and is recognised as an invasive alien plant in Northern Europe. It is to date present in a limited number of localities in Belgium and poorly established within the LIFE RIPARIAS territory (Verloove 2021).

3/ **Manchurian wild rice *Zizania latifolia***. Often grown as a cover for water birds*, Z. latifolia* is a perennial plant growing up to 4 m tall at the shore of lakes, ponds, ditches or wetlands with stagnant or slowly flowing water (Yang *et al* 2020). It can damage riparian plant communities by overtopping and suppressing them. It is difficult to eradicate because any rhizome fragments will regrow (Liatukas & Stukonis 2009). It is native to China, India, Japan, Korea, Russia and Vietnam and behaves as an invasive alien plant in New Zealand and Northern Europe (Liatukas & Stukonis 2009). It is naturalised in scattered locations across Belgium and is spreading slowly (Verloove 2021).

4/ **Large-flowered waterweed *Egeria densa***. This is a submerged aquatic dioecious plant, widely sold for aquarium cultivation and as an oxygenating plant for ponds and goldfish bowls. It often spreads by vegetative means as many introduced populations comprise only male plants. It is native to South America and recognised as very invasive in Australia, New Zealand and USA, where it outcompetes native vegetation and impairs the functioning of aquatic habitats (Landsdown 2011, Branquart *et al* 2013b, Anonymous 2019). It is also known to be invasive in France (Muller 2004) and is managed in many places (GT IBMA 2016). Only limited occurrences and impacts are currently known from Belgium (Verloove 2021) but its distribution could well be underestimated (Denys *et al* 2004).

5/ **Monkeyflower *Erythranthe guttata*** (syn. *Mimulus guttatus*). This small annual herb produces leafy stolons and numerous seeds that easily disperse along watercourses. It grows on banks of streams, rivers and lakes, as well as in wet pastures (Tokarska-Guzik & Dajdok 2010). Its ecological impact is assessed as moderate because large populations are often ephemeral and mostly found in disturbed habitats, where they may outcompete ruderal plant species of low conservation value (Matthews *et al* 2012). Native to North America, it is recognised as an invasive alien plant in several countries from Northern Europe. In Belgium, this ornamental plant was first recorded in the wild in 1953 and is widespread and locally abundant within the Ardenne, Flandrian and Campine districts; it is however still poorly established within the LIFE RIPARIAS territory (Baus *et al* 2009, Verloove 2021). This species has been removed from most ornamental plant catalogues in Belgium since the elaboration of the LIFE ALTERIAS code of conduct (Halford *et al* 2014), but is still present in trade under the label

'*Mimulus luteus*' (Van den Neucker & Scheers, submitted) together with other species of the same genus.

6/ **Cape pondweed *Aponogeton distachyos***. This submerged and floating perennial aquatic plant grows in still and slow-flowing waters up to 1.5 m deep. *Aponogeton distachyos* has an extensive system of tuberous rhizomes. It spreads through seeds or root fragments. Seeds would sink quickly and germinate almost immediately in the vicinity of the mother plant (Romanowski 2011). Native to South Africa, it is considered as an invasive alien plant in Australia and New Zealand where it moderately affects native plants and aquatic ecosystems (Duenas & Newan 2017, Weiss & Dugdale 2017). In Belgium, this ornamental plant was first recorded in the wild in 1993 and is now present in a few scattered localities; a large spreading population is present/occurs in the Zwarte Beek valley in high conservation value habitat with native *Potamogeton* spp. (Verloove 2021) and is under management by the Flemish Environment Agency and Natuurpunt vzw (Slootmaekers & Van Onsem 2021).

7/ **Chameleon plant *Houttuynia cordata***. Chameleon plant is a perennial herbaceous plant with a great ability for rapid vegetative propagation by means of rhizomes and creeping stems. It is often introduced as an ornamental in gardens and ponds. Native to China and India, it has been observed to make dense groundcover and rapidly displace native plants in riparian forests and wetlands in North America and New Zealand. Chameleon plant is extremely difficult and costly to control due to vegetative propagation and high resistance to herbicides (GISD 2021, Licari *et al* 2021). In Belgium, it is rare but increasingly escapes from cultivation or garden throw-out but is not yet fully naturalised (Verloove 2021).

8/ **Lizard's tail *Saururus cernuus***. This perennial herbaceous plant has a submerged and an emerged form, growing within waterbodies as well as on banks of ponds and slow-moving watercourses. It is very tolerant to water level fluctuations (Delaunay 2005). Within its introduced range (Australia and New Zealand), this plant native to North America is mainly reproducing by rhizome extension and locally produces very dense populations (NIWA 2020). In Belgium, it is established in a very limited number of localities (Flandrian and Kempen districts) (Denys *et al.* 2008, Adriaens *et al.* 2009) and it mainly spreads from discarded aquarium and garden waste (Verloove 2021).

9/ **Himalayan knotweed *Koenigia polystachya*** (syn. *Polygonum polystachyum* and *Persicaria wallichii*). Himalayan knotweed is a perennial herb growing up to 120 cm tall that creates large and dense stands which can outcompete native plants along riverbanks and in riparian areas, but also in man-made habitats. It reproduces mostly vegetative from extensive rhizomes (van de Witte 2015, Tanner & Branquart 2018). Native to India, it is reported as an invasive plant in North America and in several European countries. In Belgium it is a rather rare, locally naturalized garden escape in the Ardenne, Flandrian and Campine districts and is poorly established in the LIFE RIPARIAS territory (Verloove 2021).

10/ **Pickerelweed *Pontederia cordata***. This tall emerged semi-aquatic plant is often cultivated as an ornamental plant in garden ponds and is very widely available. Native to Northern and Southern America, pickerelweed is considered as an invasive plant in marshes, ditches and pond margins of South Africa, Australia and probably also the United Kingdom; as far as is known, it only reproduces through rhizome fragments in its introduced range (Lansdown 2019, Wansell 2021). In Belgium, it is established in a small number of semi-natural sites, especially in the Kempen, where it was often deliberately planted. It is a prolific grower that can readily cover large areas and outcompete native plants (Verloove 2021).

Egeria densa,
photo by Lamiot (Wikimedia)

Aponogeton distachyos,
photo by Lamiot (Wikimedia)

Erythranthe guttata, photo by Contrats de Rivière de Wallonie & Etienne Branquart

Houttuynia cordata,
photo by Megachile (iNaturalist)

Pontederia cordata,
photo by Etienne Branquart

Zizania latifolia,
photo by Jo Packet

Figure 3 - Pictures of some aquatic and riparian plants included in the alert list

3.2 Alert list of alien crayfish

The crayfish alert list consists of 2 species from pet catalogues (i.e. *Cherax destructor* and *Procambarus acutus*) and 5 additional species not mentioned in catalogues but known to be invasive in neighbouring areas (i.e. *Faxonius immunis, F. juvenilis, F. rusticus, F. virilis*) or poorly established in the LIFE RIPARIAS territory (*Procambarus virginalis*) (table 1). Of the alert list, only P. virginalis and P. acutus are currently known to occur in Belgium with a limited number of populations. This results in 7 species briefly described below. These species have a high to very high environmental risk score, with a moderate to high confidence level (see Willeput 2021 for details).

	Belgian status	First occurrence	Suitable climatic zones	A08 - INTRO	A09 - ESTA	A11 - SPR	A13 - PRED	A16 - DIS	Environmental risk		
									Score	Rating	CL
High and very high risk											
Procambarus acutus	Nat.	2013	Cfa, Cfb, Dfb	VH	VH	VH	H	VH	**0,75**	**VH**	H
*Faxonius virilis**	Abs.	/	Cfa, Cfb, Dfb	H	VH	VH	H	VH	**0,63**	**VH**	H
Faxonius rusticus	Abs.	/	(Cfa), Dfb	L	VH	VH	H	VH	**0,55**	**VH**	H
Faxonius immunis	Abs.	/	Dfb	H	VH	VH	H	VH	**0,60**	**VH**	M
Cherax destructor	Abs.	/	Cfa, Cfb	M	H	VH	H	H	**0,46**	**VH**	M
*Procambarus virginalis**	Nat.	2017	Cfa, Cfb	H	VH	VH	M	VH	**0,40**	**VH**	M
Faxonius juvenilis	Abs.	/	Cfa, Dfb	L	VH	H	M	VH	**0,25**	**H**	M

Table 2 – Occurrence, climatic zones suitable for establishment, environmental risk scores and confidence levels (CL) of alien crayfish included into the LIFE RIPARIAS alert list based on the Harmonia+ risk assessment protocol (D'hondt *et al* 2015). Abbreviations: Abs(ent), Nat(uralised), intro(duction), esta(blishment), spr(ead), pred(ation) and dis(ease transmission). Climatic zones are described in figure 2. Ratings: L (low), M (medium), H (high) and VH (very high). Species of EU concern already listed under Regulation EU No 1143/2014 are identified by *.

1/ **White river crayfish *Procambarus acutus*.** This pale orange to dark red crayfish is often confused with *P. clarkii* and *P. zonangulus* (Swecker *et al* 2010). Native to North America, it is mainly found in lentic water bodies, slow flowing streams and ephemeral wetland habitats. Like *P. clarkii*, it is an ecosystem engineer that can cause major environmental damage and transform macrophyte - dominated, clear water into phytoplankton-driven turbid water (Gherardi 2009). It is also a vector of the crayfish plague which is lethal to native European crayfish species. In Europe, white river crayfish is known from Great Britain, the Netherlands and Belgium (4 localities) as an escapee from aquaculture facilities and ornamental ponds. Its current distribution in Belgium could be underestimated due to the absence of dedicated crayfish monitoring and species misidentification (Scheers *et al* 2020).

2/ **Virile crayfish *Faxonius virilis*.** This medium to large crayfish (up to 13 cm) can vary in body colour from light to a dark brown (Souty-Grosset *et al* 2006). Native to North America, this generalist crayfish thrives in fast rocky streams, canals and ponds. In its native range, this aggressive crayfish has been

shown to outcompete other species and is considered as a habitat transformer. It is also a vector of the crayfish plague. Is was introduced in Great Britain and in the Netherlands in 2004 from released aquarium specimens (Ellis 2012) and very recently also turned up in France (Bouchard 2021). The virile crayfish has not been observed in Belgium, so far.

3/ **Rusty crayfish *Faxonius rusticus*.** This brownish-green crayfish (up to 10 cm) lives in a wide range of climatic and habitat conditions, including ponds and shallow streams. In case of water drawdown or frost, it burrows in fine sediment (Guiaşu & Labib 2021). Native to Indiana, it strongly expanded its distribution range in North America due to multiple introductions by anglers (bait). It was shown to outcompete native crayfish due to more aggressive behaviour and significantly impacts macrophytes and macroinvertebrates, including mussels and snails. It is also a vector of the crayfish plague (Tricarico 2019). In Europe, this species was recently recorded in France (Collas 2019).

4/ **Calico crayfish *Faxonius immunis*.** This rather small crayfish (4-9 cm) is grey in colour with a median pale stripe (Tack 1941). Native to the eastern part of North America, it is found in a wide range of habitats, from small streams to slow flowing rivers and ditches. Higher densities are observed in stagnant waters where they increase turbidity through their deep burrowing activities. It is also a vector of the crayfish plague (Francois *et al* 2019). It is established in Germany, France and the Netherlands (Collas 2017, Hermann *et al* 2018, Lemmers *et al* 2020), but no observations have been reported from Belgium so far.

5/ **Yabby crayfish *Cherax destructor*.** This very large crayfish (up to 30 cm in warm conditions) is greenish in the wild and blue-grey in captivity. Native to Australia, it lives in a wide range of habitat (swamps, streams, ponds) and climatic conditions, although preferring well-oxygenated waters (Nguyen *et al.*, 2004). This opportunistic, omnivorous crayfish feeds on macroinvertebrates, amphibians, fish or young crayfish in times of scarcity. Yabbies dig burrows which can be 0.5-2 m deep to shelter during low water conditions; their burrowing behaviour can make the banks of invaded waterbodies unstable and susceptible to collapse (Gherardi & Sabapathy 2011). Yabby is a potential vector of crayfish plague and other diseases, such as *Thelohania parastaci* (Moodie *et al* 2003). In Europe, established populations of yabby are found in France (Brittany), Italy and Spain. Cherax destructor was also identified as a high-risk potential invasive species for the Netherlands (van Kuijk et al. 2021) based on a recent risk assessment for crayfish present in the Dutch aquarium trade with the FI-ISK protocol, an invasiveness screening tool for non-native freshwater invertebrates (Tricarico et al. 2010).

6/ **Marbled crayfish *Procambarus virginalis*.** This medium sized crayfish (10-13 cm) has a characteristic marbled colour pattern and small claws (Lyko, 2017). Only known from aquaria, genetic studies confirm that this taxon is closely related to *P. alleni* and *P. fallax*, two North American species which are confined to the subtropical and tropical climate of Florida. Nowadays, the marbled crayfish is established in Madagascar, Eastern Asia and 16 European member states due to multiple releases from aquarium facilities (Chucholl 2011, EASIN). It is considered as a perfect invader due to its parthenogenetic reproduction. It can deteriorate lentic habitats by consuming a large amount of macrophytes and macroinvertebrates (Chucholl 2011). Four established populations have been recently detected in the North of Belgium, of which two populations (an artificial ornamental basin in Heverlee and the large eutrophic ponds at the provincial domain of Kessel-Lo) occur in the Demer caption within the LIFE RIPARIAS project area (Scheers *et al* 2021).

7/ **Kentucky River crayfish *Faxonius juvenilis***. This medium-sized (up to 8 cm) brown-green crayfish lives in a wide range of habitats, both lotic and lentic (Taylor & Schuster 2004). Morphologically similar to *Faxonius rusticus*, these two species have long been considered synonymous (Hobbs 1989, Chucholl & Daudey 2008). Native to Kentucky, this species was introduced by humans outside its native range in the United States, probably as a fishing bait (Taylor 2000). Although the ecology and

impacts of introduction of *Faxonius juvenilis* are poorly documented, its ecological traits are assumed to be similar to those of *Faxonius rusticus*. Furthermore, it is a vector of the crayfish plague and therefore represents a potential significant threat to native European crayfish species (Chucholl & Daudey 2008). In Europe, *Faxonius juvenilis* was introduced in France by deliberate stocking for human consumption, where a population is established for several years (Chucholl & Daudey 2008, Collas *et al* 2015). No observation was reported in the wild from Belgium so far.

Procambarus acutus,
photo by Billi Krochuk (iNaturalist)

Procambarus virginalis,
photo by André Karwath

Faxonius virilis,
photo by Clarissc (iNaturalist)

Cherax destructor,
photo by Adam Yates (iNaturalist)

Figure 4 - Pictures of some crayfish included in the alert list

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