NAT. CROAT. | VOL. 27 | No 2 | 357-398 | ZAGREB | December 31, 2018

professional paper / stručni rad
DOI 10.20302/NC.2018.27.26

INVASIVE ALIEN SPECIES OF UNION CONCERN (REGULATION 1143/2014) IN CROATIA

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Boršić, I., Ješovnik, A., Mihinjač, T., Kutleša, P., Slivar, S., Cigrovski Mustafić, M. & Desnica, S.: Invasive Alien Species of Union Concern (Regulation 1143/2014) in Croatia. Nat. Croat., Vol. 27, No. 2, 357-398, Zagreb, 2018.

Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species creates the framework for the prevention, minimization, and mitigation of the harmful effects of invasive alien species on biodiversity in the European Union. Commission Implementing Regulations 2016/1141 and 2017/1263 delivered the list of invasive alien species of Union concern ("the Union list"). Out of 49 species on the Union list, 17 species are present in Croatia. They include five plants (Plantae), three crustaceans (Crustacea), two freshwater fish (Actinopterygii), one reptile (Reptilia), one bird (Aves), and five mammals (Mammalia). Their systematics and biology, native and introduced range, history of introduction, pathways of introduction to Croatia, impact in the introduced range, including any known impacts in Croatia, are presented. Furthermore, their distribution in Croatia, based on the available data, is shown on the distribution maps.

Key words: non-native species, Croatia, distribution, fauna, flora

Boršić, I., Ješovnik, A., Mihinjač, T., Kutleša, P., Slivar, S., Cigrovski Mustafić, M. & Desnica, S.: Invazivne strane vrste koje izazivaju zabrinutost u Uniji (Uredba 1143/2014) prisutne u Hrvatskoj. Vol. 27, No. 2, 357-398, Zagreb, 2018.

Uredba 1143/2014 o sprječavanju i upravljanju unošenja i širenja invazivnih stranih vrsta određuje okvir za sprječavanje, svođenje na najmanju moguću mjeru i ublažavanje štetnih učinaka invazivnih stranih vrsta na bioraznolikost u Europskoj uniji. Provedbenim uredbama Komisije 2016/1141 i 2017/1263 donesen je popis invazivnih stranih vrsta koje izazivaju zabrinutost u Uniji ("Unijin popis"). Od ukupno 49 vrsta na Unijinom popisu, 17 vrsta je prisutno u Hrvatskoj. One uključuju pet biljaka (Plantae), tri raka (Crustacea), dvije slatkovodne ribe (Actinopterygii), jednog gmaza (Reptilia), jednu pticu (Aves) i pet sisavaca (Mammalia). Ovdje predstavljamo njihovu sistematiku i biologiju, prirodno područje rasprostranjenosti i područje unosa, povijest unosa, putove unosa u Hrvatsku, utjecaj u području unosa, uključujući i poznate utjecaje u Hrvatskoj. Također, njihova rasprostranjenost u Hrvatskoj, temeljem dostupnih podataka, prikazana je kartama rasprostranjenosti.

Ključne riječi: fauna, flora, Hrvatska, rasprostranjenost, strana vrsta

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INTRODUCTION

Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species, which entered into force on 1 January 2015, systematically deals with the problem of invasive alien species (IAS) at the level of the European Union (EU, 2014). This Regulation is binding in its entirety and directly applies to all Member States, including Croatia. It sets out rules to prevent, minimize, and mitigate the harmful effects of invasive alien species on biodiversity in the European Union. The framework for its implementation in Croatian legislation is set by the new Act on the Prevention and Management of the Introduction and Spread of Alien and Invasive Alien Species (Anonymous, 2018) and its subordinate legislation.

According to the Regulation, the Commission delivers a list of invasive alien species of Union concern ("the Union list"). To be considered for the list each species must be proposed by the European Commission or one of the Member States, which then conducts a comprehensive risk assessment. The risk assessment is a document that contains description of the species' taxonomy, distribution and ecology, the possible pathways of its introduction and spread, known and potential adverse impacts on biodiversity, ecosystem services, human health, safety and economy, including the assessment of possible benefits. The assessed alien species can be added to the list if it meets a predefined set of criteria, such as: it must be able to establish a viable population and spread, it needs to be likely that it would have a significant adverse impact on biodiversity, related ecosystem services, human health or the economy, and it has to be likely that listing the species on the Union list will effectively prevent, reduce or mitigate these adverse effects. Furthermore, it has to be approved by the IAS Committee. After the listing of a species on the Union list, its import, trade, breeding, growing, and keeping are restricted (EU, 2014).

The Regulation also sets measures to combat the negative impact of invasive alien species through prevention, early detection, and rapid eradication. This approach, which focuses on prevention and eradication measures in early stages of invasion, is based on numerous studies that show that eradication or control of IAS after the population has established and reached a certain size is either exceedingly hard or impossible, and often accompanied with large economic losses (Veitch & Clout, 2002; Anderson, 2005).

The Union list must be comprehensively reviewed at least every six years, and in the meantime new species can be added or removed according to the procedures prescribed in the Regulation (EU, 2014). The first list of invasive alien species of Union concern, adopted by Commission Implementing Regulation (EU) 2016/1141 of 13 July 2016 (EC, 2016), included a total of 37 species. On 12 July 2017, 12 more species were added to the Union list by Commission Implementing Regulation (EU) 2017/1263 (EC, 2017), bringing the current number of species on the Union list to 49 (Tab. 1).

In this paper we provide baseline data about the invasive alien species from the Union list currently known in Croatia, including their distribution, history of introduction, biology, and impact on biodiversity. Although there are other invasive alien species in Croatia, they are not included on the Union list and therefore not in the scope of this paper.

MATERIALS AND METHODS

Study area

Croatia is a south-eastern European country situated on the eastern coast of the Adriatic Sea, with a land area of 56,594 km^2 and a sea area of 31,067 km^2. It spans three biogeographical regions: Mediterranean, Alpine, and Continental (EEA, 2016). The Continental biogeographical region is predominantly flat, with the floodplains of the Sava, Mura, Drava, and Danube rivers. The Alpine biogeographical region contains geomorphologically diverse Dinaric Mountains (highest elevation 1831 meters) dominated by fir and beach forests. The Mediterranean biogeographical region comprises the eastern Adriatic coast and the islands. The mean annual temperature in Croatia ranges from 3°C in the mountain areas, to 17°C along the coast and on the islands. The mean annual amount of precipitation ranges from 300 mm on the outer southern Adriatic islands (the island of Palagruža) to over 3500 mm in the mountain region (Gorski kotar, Velebit Mountain) and the Konavle Plain (Zaninović *et al*., 2008).

Terminology

The terminology used throughout the manuscript is adapted from Richardson (2000), Copp *et al.* (2005), Regulation 1143/2014 (EU, 2014), and NOBANIS (2015):

Alien species (syn. non-native, non-indigenous, exotic) – any species found outside its natural range.

Casual species – an alien species that is found only occasionally, and may occasionally reproduce, but is still unable to form self-replacing populations. Its presence in introduced range relies on repeated introductions.

Door knocker species – an alien species that is not yet introduced or established, but is expected to arrive in the near future.

Introduction – the human-mediated movement, intentional or unintentional, of a species outside its natural range.

Naturalized species (syn. established) – an alien species that reproduces independently and that is capable of sustaining a viable population in the introduced range.

Invasive alien species (IAS) – an alien species whose introduction or spread has been found to threaten or adversely impact biodiversity and related ecosystem services, human health, and the economy.

Invasive alien species of Union concern – an invasive alien species whose current or potential adverse effects on biodiversity or the related ecosystem services are such that they require coordinated action at Union level.

Species data outline

All nomenclature follows the implementing regulations (EC, 2016, 2017). When the regulation's nomenclature is not in agreement with the most recent taxonomic changes, we address this accordingly. For species for which Croatian vernacular names do not exist in literature, we devised them from English names.

For each species we summarize the following: systematics and biology, native and introduced range, history of introduction, introduction pathway to Croatia, species' impact in its introduced range, including any known impacts in Croatia.

We obtained the distribution data for Europe from European and global databases and projects (e. g. NOBANIS, 2017; CABI, 2018a; DAISIE, 2018; EASIN, 2018; GRIIS, 2018), as well as from national check-lists of alien and invasive alien species (e. g. Pyšek *et al.*, 2012). For plant species existing data from the Flora Croatica Database (Nikolić, 2018) were used. For animal taxa, in addition to the listed databases, we obtained the data from literature and the Croatian Agency for Environment and Nature database (CAEN, 2018). Distribution maps were prepared using ESRI GIS ArcMap 10.1 software. Although the real distribution of some species (e. g. *Pseudorasbora parva*) in Croatia is probably wider than shown on the distribution maps, only known distribution data are shown.

RESULTS AND DISCUSSION

Out of 49 invasive alien plant and animal species of Union concern, there are 17 species present in Croatia, including five plant species (one Liliopsida and four Magnoliopsida), three freshwater crayfish (Malacostraca), two freshwater fish (Actinopterygii), one reptile (Reptilia), one bird (Aves), and five mammals (Mammalia) (Tab. 1, Figs. 1, 2). Two additional animal species from the Union list, *Lithobates catesbeianus* (Amphibia) and *Eriocheir sinensis* (Malacostraca), are established in neighbouring countries and recorded near the Croatian border, so their presence in Croatia is possible. Furthermore, three plant species from the Union list, *Eichhornia crassipes* (Martius) Solms, *Ludwigia peploides* (Kunth) P.H. Raven, and *Pennisetum setaceum* (Forssk.) Chiov. are not listed in the check list of Croatian vascular flora (Nikolić, 2018) and, to our present knowledge, are not present in the wild in Croatia. However, it is likely that they are present in Croatia as ornamental species in cultivation. The species *Eichhornia crassipes* and *Ludwigia peploides* are sold via the internet for aquaria and fish ponds, while *Pennisetum setaceum* is also on sale by some plant nurseries, despite Regulation restrictions.

PLANTS

There are five vascular plant species of Union concern present in Croatia: *Asclepias syriaca* L., *Elodea nuttallii* (Planch.) St. John, *Heracleum mantegazzianum* Sommier & Levier, *Impatiens glandulifera* Royle, and *Myriophyllum heterophyllum* Michaux.

***Asclepias syriaca* L. – common milkweed (Croatian: pravo cigansko perje,** prava svilenica**); Figs. 1a, 3**

Species *Asclepias syriaca* is a perennial herb up to 150 cm tall with branched rhizome. Leaves are opposite, simple, entire, ovate-oblong, acute at apex and rounded at base. They are white-pubescent beneath and dark green, sparsely pubescent above. Flowers are entomophilous, 5-merous, actinomorphic, built in the specific way characteristic of the family Asclepiadaceae, with pink corona composed of hoods and horns. Inflorescences are many-flowered terminal or axillary, subglobose to globose umbels. Fruit consists of a pair of white-pubescent, sulcate and spiny follicles, but usually only one follicle develops. Seeds are numerous, flat, brown and with a tuft of silky white hairs apically. They are spread by wind (anemochory). It flowers from June to August (Heywood, 1972; Petrova *et al.*, 2013; Nikolić *et al.*, 2014).

Tab. 1. List of invasive alien species of Union concern.

Kingdom	Class	Species	English name	Croatian name	Presence in Croatia	Implementing Regulation	Entry into force
Animalia	Aves	*Alopochen aegyptiacus* Linnaeus, 1766	Egyptian goose	egipatska guska	Present	EU (2017)	August 2, 2017
Plantae	Magnoliopsida	*Alternanthera philoxeroides* (Mart.) Griseb.	Alligator weed	aligatorski korov	Not present	EU (2017)	August 2, 2017
Plantae	Magnoliopsida	*Asclepias syriaca* L.	Common milkweed	cigansko perje	Present	EU (2017)	August 2, 2017
Plantae	Magnoliopsida	*Baccharis halimifolia* L.	Eastern baccharis	istočnoamerički baharis	Not present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Cabomba caroliniana* Gray	Carolina fanwort	kabomba	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Callosciurus erythraeus* Pallas, 1779	Pallas's squirrel	Pallasova vjeverica	Not present	EU (2016)	August 3, 2016
Animalia	Aves	*Corvus splendens* Viellot, 1817	Indian house crow	indijski gavran	Not present	EU (2016)	August 3, 2016
Plantae	Liliopsida	*Eichhornia crassipes* (Martius) Solms	Water hyacinth	vodeni zumbul	Not present?	EU (2016)	August 3, 2016
Plantae	Liliopsida	*Elodea nuttallii* (Planch.) St. John	Nuttall's waterweed	Nuttallova vodena kuga	Present	EU (2017)	August 2, 2017
Animalia	Malacostraca	*Eriocheir sinensis* H. Milne Edwards, 1854	Chinese mittencrab	kineska rakovica	Not present?	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Gunnera tinctoria* (Molina) Mirbel	Chilean rhubarb	čileanska gunera	Not present	EU (2017)	August 2, 2017
Plantae	Magnoliopsida	*Heracleum mantegazzianum* Sommier & Levier	Giant hogweed	divovski svinjski korov	Present	EU (2017)	August 2, 2017
Plantae	Magnoliopsida	*Heracleum persicum* Fischer	Persian hogweed	perzijski svinjski korov	Not present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Heracleum sosnowskyi* Mandenova	Sosnowsky's hogweed	Sosnowskijev svinjski korov	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Herpestes javanicus* É. Geoffroy Saint-Hilaire, 1818*	Small Indian mongoose	mali indijski mungos	Present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Hydrocotyle ranunculoides* L. f.	Floating pennywort	žabnjački ljepušak	Not present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Impatiens glandulifera* Royle	Indian balsam	žljezdasti nedirak	Present	EU (2017)	August 2, 2017

Tab. 1. Continued

Kingdom	Class	Species	English name	Croatian name	Presence in Croatia	Implementing Regulation	Entry into force
Plantae	Liliopsida	*Lagarosiphon major* (Ridley) Moss	Curly waterweed (African elodea)	veliki lagarosifon (afrička vodena kuga)	Not present	EU (2016)	August 3, 2016
Animalia	Amphibia	*Lithobates (Rana) catesbeianus* Shaw, 1802	American bullfrog	sjevernoamerička žaba bukača	Not present?	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Ludwigia grandiflora* (Michx.) Greuter & Burdet	Water primrose	velecvjetna močvarna mekčina	Not present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Ludwigia peploides* (Kunth) P.H. Raven	Floating primrose-willow	plutajuća močvarna mekčina	Not present?	EU (2016)	August 3, 2016
Plantae	Liliopsida	*Lysichiton americanus* Hultén and St. John	American skunk cabbage	američki lisihiton	Not present	EU (2016)	August 3, 2016
Plantae	Liliopsida	*Microstegium vimineum* (Trin.) A. Camus	Japanese stiltgrass	japanska štulavka	Not present	EU (2017)	August 2, 2017
Animalia	Mammalia	*Muntiacus reevesii* Ogilby, 1839	Muntjac deer	jelen muntjak	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Myocastor coypus* Molina, 1782	Coypu	barska nutrija	Present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Myriophyllum aquaticum* (Vell.) Verdc.	Parrot's feather	vodeni krocanj	Not present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Myriophyllum heterophyllum* Michaux	Broadleaf watermilfoil	raznolisni krocanj	Present	EU (2017)	August 2, 2017
Animalia	Mammalia	*Nasua nasua* Linnaeus, 1766	South-American coati	nosati rakun ili koati	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Nyctereutes procyonoides* Gray, 1834	Raccoon dog	rakunopas ili kunopas	Present	EU (2017)	February 2, 2019
Animalia	Mammalia	*Ondatra zibethicus* Linnaeus, 1766	Muskrat	bizamski štakor	Present	EU (2017)	August 2, 2017
Animalia	Malacostraca	*Orconectes limosus* Rafinesque, 1817	Spiny-cheek crayfish	bodljobradi rak	Present	EU (2016)	August 3, 2016
Animalia	Malacostraca	*Orconectes virilis* Hagen, 1870	Virile crayfish	virilan rak	Not present	EU (2016)	August 3, 2016
Animalia	Aves	*Oxyura jamaicensis* Gmelin, 1789	Ruddy duck	grimizna patka	Not present	EU (2016)	August 3, 2016
Animalia	Malacostraca	*Pacifastacus leniusculus* Dana, 1852	Signal crayfish	signalni rak	Present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Parthenium hysterophorus* L.	Whitetop weed (parthenium weed)	partenium	Not present	EU (2016)	August 3, 2016

Tab. 1. Continued

Kingdom	Class	Species	English name	Croatian name	Presence in Croatia	Implementing Regulation	Entry into force
Plantae	Liliopsida	*Pennisetum setaceum* (Forssk.) Chiov.	Crimson fountaingrass	čekinjasta trava	Not present?	EU (2017)	August 2, 2017
Animalia	Actinopterygii	*Perccottus glenii* Dybowski, 1877	Chinese sleeper	rotan	Present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Persicaria perfoliata* (L.) H. Gross (*Polygonum perfoliatum* L.)	Asiatic tearthumb (mile-a-minute weed)	prorasla perzikarija	Not present	EU (2016)	August 3, 2016
Animalia	Malacostraca	*Procambarus clarkii* Girard, 1852	Red swamp crayfish	crveni močvarni rak	Not present	EU (2016)	August 3, 2016
Animalia	Malacostraca	*Procambarus fallax* (Hagen, 1870) f. *virginalis*	Marbled crayfish	mramorni rak	Present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Procyon lotor* Linnaeus, 1758	Raccoon	rakun	Present	EU (2016)	August 3, 2016
Animalia	Actinopterygii	*Pseudorasbora parva* Temminck & Schlegel, 1846	Stone moroko (top-mouth gudgeon)	bezribica	Present	EU (2016)	August 3, 2016
Plantae	Magnoliopsida	*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) (*Pueraria lobata* (Willd.) Ohwi)	Kudzu vine	penjačica kudzu	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Sciurus carolinensis* Gmelin, 1788	American grey squirrel	siva vjeverica	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Sciurus niger* Linnaeus, 1758	Fox squirrel	Bryantova vjeverica	Not present	EU (2016)	August 3, 2016
Animalia	Mammalia	*Tamias sibiricus* Laxmann, 1769	Siberian chipmunk	sibirska vjeverica	Not present	EU (2016)	August 3, 2016
Animalia	Aves	*Threskiornis aethiopicus* Latham, 1790	Sacred ibis	sveti ibis	Not present	EU (2016)	August 3, 2016
Animalia	Reptilia	*Trachemys scripta* Schoepff, 1792	Slider (red-eared/ yellow-bellied)	crvenouha/ žutouha kornjača	Present	EU (2016)	August 3, 2016
Animalia	Insecta	*Vespa velutina nigrithorax* de Buysson, 1905	Asian hornet	azijski stršljen	Not present	EU (2016)	August 3, 2016

* see Taxonomic notes

Fig. 1. Species of Union concern present in Croatia: a) *Asclepias syriaca* L. (photo by I. Boršić); b) *Elodea nuttallii* (Planch.) St. John (photo by A. Kočić); c) *Heracleum mantegazzianum* Sommier & Levier (photo by I. Boršić); d) *Impatiens glandulifera* Royle (photo by I. Boršić); e) *Myriophyllum heterophyllum* Michaux (photo by I. Boršić); f) *Orconectes limosus* (Rafinesque, 1817) (photo by S. Hudina); g) *Pacifastacus leniusculus* (Dana, 1852) (photo by L. Katušić); h) *Procambarus fallax* (Hagen, 1870) f. *virginalis* (photo by M. Samardžić).

Fig. 2. Species of Union concern present in Croatia: a) *Pseudorasbora parva* Dybowski, 1877 (photo by P. Mustafić); b) *Perccottus glenii* (Temminck & Schlegel, 1846) (photo by P. Mustafić); c) *Trachemys scripta* (Schoepff, 1792) (photo by I. Boršić); d) *Alopochen aegyptiacus* (Linnaeus, 1766) (source: Wikimedia Commons); e) Small Indian mongoose (photo by M. Franković, NP Mljet archives); f) *Myocastor coypus* (Molina, 1782) (photo by I. Boršić); g) *Nyctereutes procyonoides* (Gray, 1834) (photo by Marie Hale); h) *Ondatra zibethicus* (Linnaeus, 1766) (photo by I. Boršić); i) *Procyon lotor* (Linnaeus, 1758) (photo by David Menke, U.S. Fish and Wildlife Service).

The native range of *A. syriaca* is eastern North America. It was introduced to Europe in 17th century as an ornamental plant (Bagi, 2008; Petrova *et al*., 2013). In Europe it is naturalized in Austria, Bulgaria, Croatia, the Czech Republic, Denmark, France, Germany, Hungary, Italy, Lithuania, the Netherlands, Poland, Romania, Slovakia, Slovenia, and Spain; and it is considered invasive in most of those countries (NOBANIS, 2017; DAISIE, 2018). Regarding its impact, it is an aggressive and persistent agricultural weed (CABI, 2018b) with negative allelopathic effects (Bagi, 2008). By infesting arable land and by distracting pollinators it causes crop losses (Bagi, 2008). It is a host for the cucumber mosaic virus (CMV) and for the pest insect *Frankliniella occidentalis* which is a vector of tomato spotted wilt virus (TSWV; Bagi, 2008). It contains glycosides that are poisonous to livestock (CABI, 2018b). It has negative physical effects (shade and space occupation) on native species (Bagi, 2008) and changes the composition of native communities (Nikolić *et al*., 2014).

Supposedly it was introduced to Croatia as an ornamental plant which subsequently escaped from cultivation and started spreading. The first records in Croatia date from the second half of the 19th century (Nikolić *et al*., 2014). It is a common, widely spread species, distributed primarily in northwestern and eastern Croatia, with rare records elsewhere (e. g. island of Lošinj, Murter, Brela) (cf. Nikolić, 2018). Although it is considered an invasive alien plant species (Boršić *et al*., 2008), it is still used as an ornamental and melliferous plant. Occupied habitats include anthropogenically influenced habitats, along the roads and railways, on river embankments, on pastures and in open forest areas (Nikolić *et al*., 2014).

***Elodea nuttallii* (Planch.) St. John – Nuttall's waterweed (Croatian: Nuttallova vodena kuga); Figs. 1b, 4**

The species *Elodea nuttallii* is a rooted, submerged freshwater perennial macrophyte. It has thin, filiform roots at the stem nodes. Stems are long, slender and often branched. Leaves are linear or linear-lanceolate, gradually tapering towards an acute apex, lower are opposite, while upper are in whorls of 3(4). It is a dioecious plant with unisexual, white-violet flowers about 4 mm wide. The male flower while still in bud breaks free and rises to the surface, where it opens and releases pollen, while the female flower also floats on the water surface, but remains connected to the plant. Fruit is a capsule, with 1-5 seeds. It flowers from June to September (Dandy, 1980; Preston & Croft, 1997; Josefsson, 2011; Petrova *et al*., 2013).

The species is native to temperate North America. In Europe it is known from the beginning of 20th century – it was recorded in Great Britain in 1914 (firstly as *Hydrilla verticillata* (L.f.) Royle), followed by a record from Belgium in 1939. It was most likely introduced as an ornamental plant which was then accidentally released from aquariums (Josefsson, 2011). Today in Europe it is naturalized in Austria, Belgium, Bulgaria, Denmark, France, Germany, Great Britain, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Romania, Serbia, Slovakia, Slovenia, Sweden, and Switzerland (Kočić *et al*., 2014; NOBANIS, 2017; DAISIE, 2018). In central Europe both male and female plants are present (Krausch, 1996), but it mainly reproduces vegetatively and spreads by vegetative fragments (Preston & Croft, 1997). It grows in eutrophic, oligo- and mesoprobic waters, where it can form dense monospecific stands, changing the chemical composition of water as well as the composition of species, e.g. displacement of other plant species (because of competition for nutrients and shading) or impact on

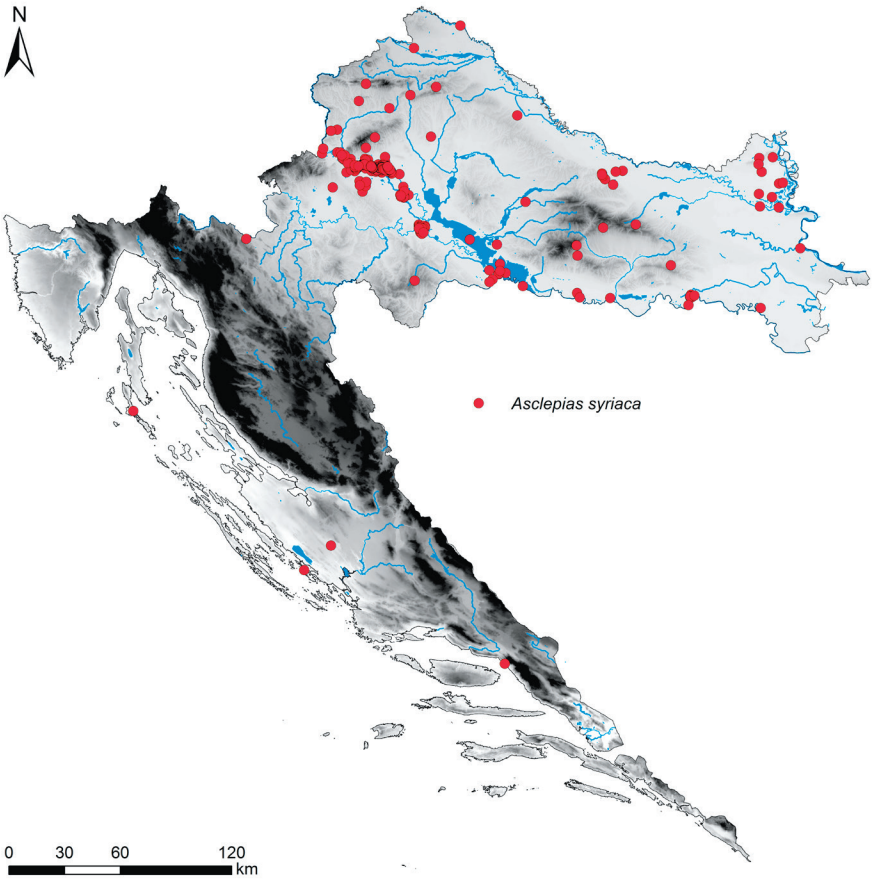

Fig. 3. Distribution of *Asclepias syriaca* L. in Croatia.

animal species. It can reduce water flow in drainage canals and negatively impact water resources and recreational activities (Josefsson, 2011; CABI, 2018c).

It was found for the first time in Croatia in 2006, in Kopački rit floodplain (the mouth of the River Drava into the Danube). Subsequently, the species became established in Baranja, where it spread along the network of drainage canals. It was most likely introduced from Hungary along the Danube River (Kočić *et al*., 2014). It was also recorded in the Drava River (Vidović, 2013; 2015), where it was apparently introduced from Slovenia (Kočić *et al*., 2014).

***Heracleum mantegazzianum* Sommier & Levier – giant hogweed (Croatian: divovski svinjski korov); Figs 1c, 4**

The species *Heracleum mantegazzianum* is a monocarpic perennial herb that persists several years in a rosette stage. It can grow up to 5 m high. It has ridged stem with purple blotches and pustulate bristles. Leaves are up to 300 cm long, alternately, ternately or pinnately lobed and coarsely toothed. Flowers are white or rarely pinkish. The inflorescence is compound umbel, with one terminal and up to eight satellite umbels. Fruits

are flattened and elliptical, narrowly winged, splitting into two mericarps, each with 3-5 strongly swollen vittae. Seeds are efficiently dispersed by water, wind and human-related factors. It flowers from June to August (Brummitt, 1968; Boršić *et al*., 2015; CABI, 2018d).

The species is native to the Western Greater Caucasus (Russia, Georgia). It was noted in Estonia in 1814, and it was reported as naturalized for the first time in 1828, in Cambridgeshire, from the plants introduced at the beginning of the 19th century to the Kew Botanic Gardens in London (Klingenstein, 2007). Later it became widely distributed due to its ornamental usage, usage as fodder plant and food plant for honeybees, and its subsequent spontaneous spread (EPPO, 2009). Today in Europe it is naturalized in numerous countries (Maslo, 2010; NOBANIS, 2017; DAISIE, 2018), and in many of them it is considered invasive (NOBANIS, 2017). Besides disturbed habitats, which it invades in high densities, forming monospecific stands, it also grows in semi-natural and natural habitats. Because of its size it has significant negative physical effects (shade and space occupation) in the invaded habitats, where it can outcompete and replace native species. Furthermore, it might hybridise with native species, especially *Heracleum sphondylium* L. (Stewart & Grace, 1984). It has a strong negative impact on human health. It produces phototoxic sap which contains photosensitizing furanocoumarins. Contact with the plant and exposure to the sunlight causes severe skin burns (Klingenstein, 2007; CABI, 2018d).

In Croatia it was first recorded in 2009 near Žabnik (Međimurje County; Stunković, 2009), where it has not been found since. In 2014 it was recorded in Gornja Šemnica (Radoboj, Krapina-Zagorje County), where it grows in the ruderal vegetation of the order *Onopordetalia acanthii* Br.-Bl. et R. Tx. ex Klika et Hadač 1944 mixed with ruderal vegetation of the class *Galio-Urticetea* Passarge ex Kopecký 1969 and in hygrophilous herbaceous vegetation of the alliance *Calthion* R. Tx. 1936 (Boršić *et al*., 2015). Although it is an ornamental plant that escapes from gardens, unintentional introduction was presumed (Boršić *et al*., 2015).

***Impatiens glandulifera* Royle – Himalayan balsam,** policeman's helmet **(Croatian: žljezdasti nedirak); Figs. 1d, 5**

The species *Impatiens glandulifera* is an annual herb up to 250 cm tall. It has a thick, glabrous and simple stem, with a 15 cm deep primary root and adventive roots that develop at the lower nodes of the stem. Leaves are opposite or in whorls of three in the upper part, lanceolate to elliptic, cuneate and glandular at the base, and with serrate margin. Flowers are showy, strongly zygomorphic, pink to purple or rarely white. The calyx is made of three sepals, two lateral sepals are small, triangular and mostly green, while the lowest sepal forms a sac that abruptly ends in a straight spur. Corolla is made of five petals, the longest upper petal and four lower petals which are fused in two lateral pairs, except their apical parts. The inflorescences are axillary racemes of up to 12 flowers. Fruit is a glabrous, clavate capsule with 5 valves, which opens explosively and disperses seeds. It flowers from June to August (Walters, 1968; Hejda, 2009; Petrova *et al*., 2013; Nikolić, 2014; CABI, 2018e).

It originates from the Himalayas, northern Pakistan, northern India, and Nepal. In Europe it was first introduced as an ornamental garden plant to the United Kingdom in 1839. Today it is naturalized in the majority of European countries (Hejda, 2009; Helmisaari, 2010; Petrova *et al*., 2013; Maslo, 2016; CABI, 2018e) and in many of them it is considered invasive (NOBANIS, 2017). It predominantly grows along river banks, but also along railways, in urban areas, in landfills, and in natural habitats such as

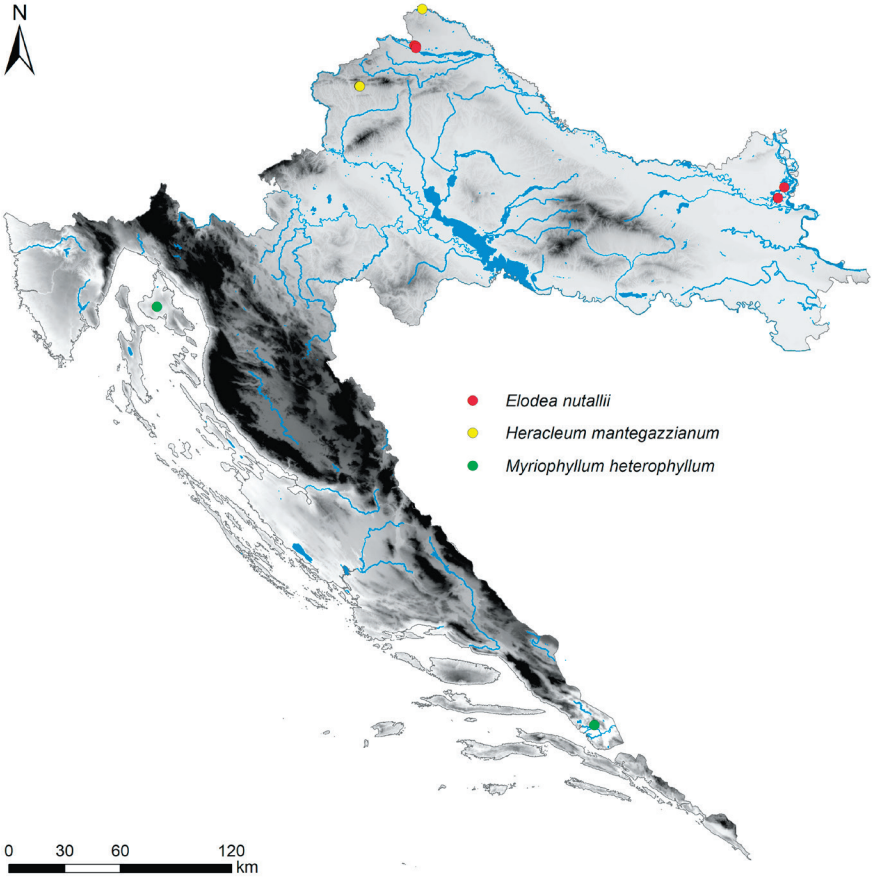

Fig. 4. Distribution of *Elodea nuttallii* (Planch.) St. John, *Heracleum mantegazzianum* Sommier & Levier, and *Myriophyllum heterophyllum* Michaux in Croatia.

forests, forest clearings, and wet meadows. Because it is an annual plant, it does not have as strong an impact on native species as some perennial invasive plants. However, it causes changes in the cover and composition of native species and can outcompete them by forming dense monospecific stands. It competes with native species for pollinators and causes changes of invertebrate communities. Furthermore, it can also impacts survival of forest seedlings (Cigić *et al.*, 2003; Helmisaari, 2010; CABI, 2018e).

In Croatia it was recorded for the first time in 1968 along the Sava River upstream of Zagreb where it spread from Slovenia (Marković, 1970). Afterwards it was discovered in Skadar in Gorski Kotar (Trinajstić, 1974). Its spread was well documented by Marković (1984), Lukač (1989), Pavletić (1993), Trinajstić & Franjić (1994), Franjić *et al*. (1998) and Pandža *et al*. (2001). It spreads along the watercourses, and from village gardens where it was used as ornamental plant (Pavletić, 1993). Today it is primarily distributed in the northwestern part of Croatia, with rare records in eastern Croatia and Pokuplje (Nikolić, 2018). It is considered an invasive alien plant species (Boršić *et al*., 2008). It is a weedy-ruderal species which occurs in various vegetation types (Marković 1984). It grows in ruderal vegetation (e.g. Ass. *Urtico-Sambucetum ebuli* Br.-

Bl. (1936) 1952; Pavletić, 1993), on disposal sites, along the roads and railways. It also occupies natural habitats; it grows along rivers, in alluvial forests and on their edges, in the alliance *Convolvulion sepium* Oberd. 1949 (forming Ass. *Impatienti-Solidaginetum* M. Moor 1958; Trinajstić, 1995).

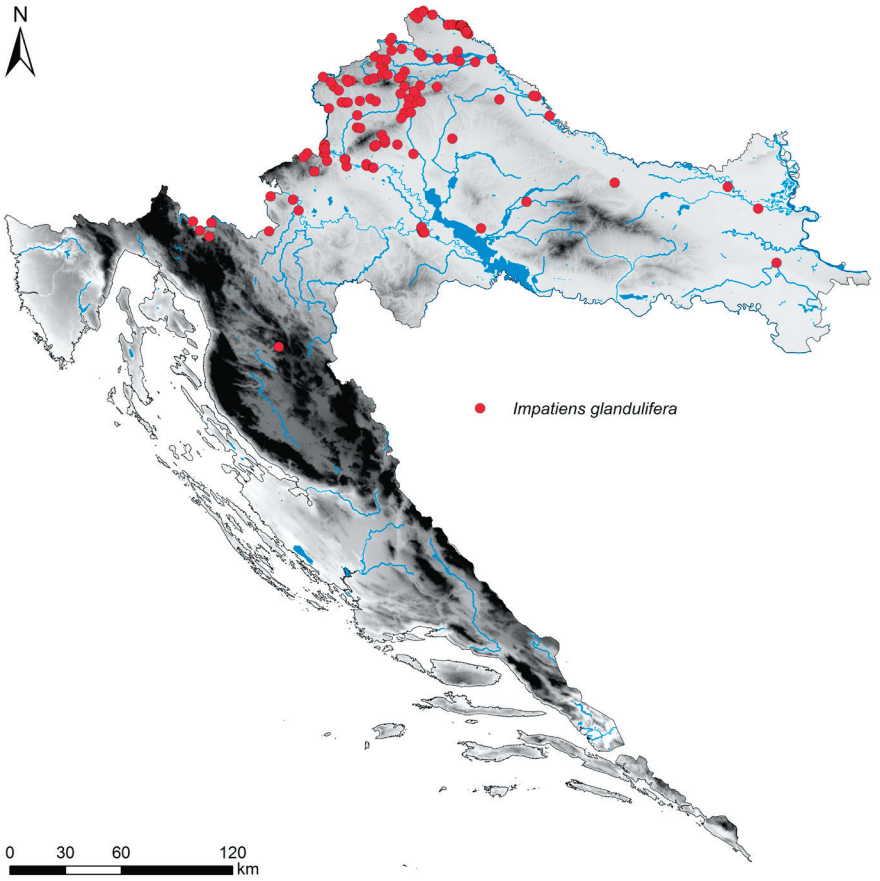

Fig. 5. Distribution of *Impatiens glandulifera* Royle in Croatia.

***Myriophyllum heterophyllum* Michaux – broadleaf watermilfoil,** changeleaf parrotfeather **(Croatian: raznolisni krocanj); Figs. 1e, 4**

The species *Myriophyllum heterophyllum* is a rhizomatous, submerged freshwater perennial macrophyte. Stems are up to 100 cm long. Leaves have different forms. Submerged leaves are feather-like and pinnate, with 4-10 pinnae. Emergent leaves are either pinnately dissected (terrestrial form) or entire toothed (an emergent leaf form, on the flowering stem). Flowers are produced only on the emergent part of the stem which can often be exposed 10–15 cm above the water surface. Spike with solitary flowers that are borne in the axils of lanceolate bracts. Flowers are usually hermaphrodite, or female flowers are occasionally at the base of the inflorescence and male above. There are four petals and no sepals. However, flowering is rarely observed. Fruit separates longitu-

dinally into four subglobose, finely tuberculate nutlets. Each nutlet is beaked and has two ridges on the outer face. It flowers from June to July (Cook, 1968; Krausch, 1996; EPPO, 2016).

The native range of *M. heterophyllum* is eastern North America. In Europe it was first discovered in 1941 in Great Britain, in a canal between Halifax and Salterhebble, where it was naturalized until the drainage of the canal in 1947 or 1948 (Preston & Croft, 1997). Today it is naturalized in Austria, Belgium, France, Germany, Hungary, Luxembourg, the Netherlands, Spain, and Switzerland (EPPO, 2015; EPPO, 2016; Lukács *et al*., 2016; DAISIE, 2018; NOBANIS, 2018). It is common in the aquarium plant trade, where it can be found under a variety of names. It grows in freshwater habitats: slowly moving rivers, canals, lakes, ponds, reservoirs, and wetlands. By forming dense mats the species can reduce oxygen availability and sunlight, and can outcompete other aquatic plants. Furthermore, it has negative effects on human activities in water by reducing water availability and flow (EPPO, 2016; CABI, 2018f).

The first record of *M. heterophyllum* for Croatia was from the small Lake Ponikve on Krk island in 2000, published nine years later (Starmühler, 2009). However, this finding passed unnoticed both in Croatia and on the international level (EPPO, 2016). The second and the most recent finding was from Lake Desne in the Neretva River Delta in 2016, where the species was growing within the vegetation of rooted leaf-floating macrophytes of the alliance *Nymphaeion albae* Oberd. 1957 and order *Potamogetonetalia* Koch 1926 (Jasprica *et al*., 2017). The mode of its introduction to Croatia is not known.

Freshwater crayfish

Three alien freshwater crayfish of Union concern are currently known for Croatia: *Procambarus fallax* (Hagen, 1870) f. *virginalis* and *Orconectes limosus* (Rafinesque, 1817) from family Cambaridae, and *Pacifastacus leniusculus* (Dana, 1852) belonging to family Astacidae, all within the order Decapoda. They originate from North America and are naturalized widely across Europe, including Croatia.

Orconectes limosus (Rafinesque, 1817) – spiny-cheek crayfish (Croatian: bodljobradi rak); Figs. 1f, 6

According to an updated classification system of the freshwater crayfishes (Decapoda: Astacidae) of the world (Crandal & De Grave, 2017) *Faxonius limosus* is the valid taxonomic name for *Orconectes limosus* (the name currently listed on the Union list). It is a small to medium sized crayfish, the largest specimens reaching just over 10 cm. The body is usually dark brown with dorsal part of abdomen striped with brown-red transversal bands. The tips of the claws are characteristically orange, bordered by a dark band. The carapace is smooth, with distinct sharp spines laterally, in front and right behind of the cervical groove. It is adapted to a wide variety of environmental conditions, including brackish waters, organic and inorganic pollution, but it predominantly occurs in larger, warmer, slow-flowing or lentic waters (Jaszczołt & Szaniawska, 2011; Alekhnovich & Buřič, 2017 and references therein).

It was the first alien crayfish intentionally introduced into Europe. It was brought to Poland from the USA in 1890s to replace the native European noble crayfish *Astacus astacus* (Linnaeus, 1758) stocks that were devastated by the crayfish plague. After introduction it had spread unaidedly through rivers and canals. It was also unintentionally translocated by human activity when used as fish bait or food, or transported with

the fish stocks (Holdich & Black, 2007). Additionally, deliberate stocking and translocation by boat traffic are possible pathways of introductions (Puky & Schád, 2006). It is present in at least 24 European countries, with the most recent records from Bulgaria in 2015 and Slovenia in 2017 (Kouba *et al*., 2014; Trichkova *et al*., 2015; Govedič, 2017).

This is a fast-growing and highly fertile species, with the capacity for rapid dispersal (Maguire & Klobučar, 2003; Kozak *et al*., 2007). For those reasons they often occur in higher densities than native crayfish and drastically affect their populations due to competition for food, and as a crayfish plague carriers (Vogt, 1999).They can also negatively affect lower trophic levels in water ecosystems (Vojkovska *et al*., 2014).

In 2003 *O. limosus* was detected in Kopački rit Nature Park in Croatia (Maguire & Klobučar, 2003). Since then it has significantly expanded its range in the Drava and Danube rivers in eastern Croatia (Maguire *et al*., 2011; Maguire *et al*., 2018). The presence of spiny-cheek crayfish in Croatia is probably the result of species dispersal from the Hungarian section of the Danube River. Although deliberate introduction for commercial purposes to and within northeastern Croatia cannot be excluded, they are unlikely (Hudina *et al*., 2009).

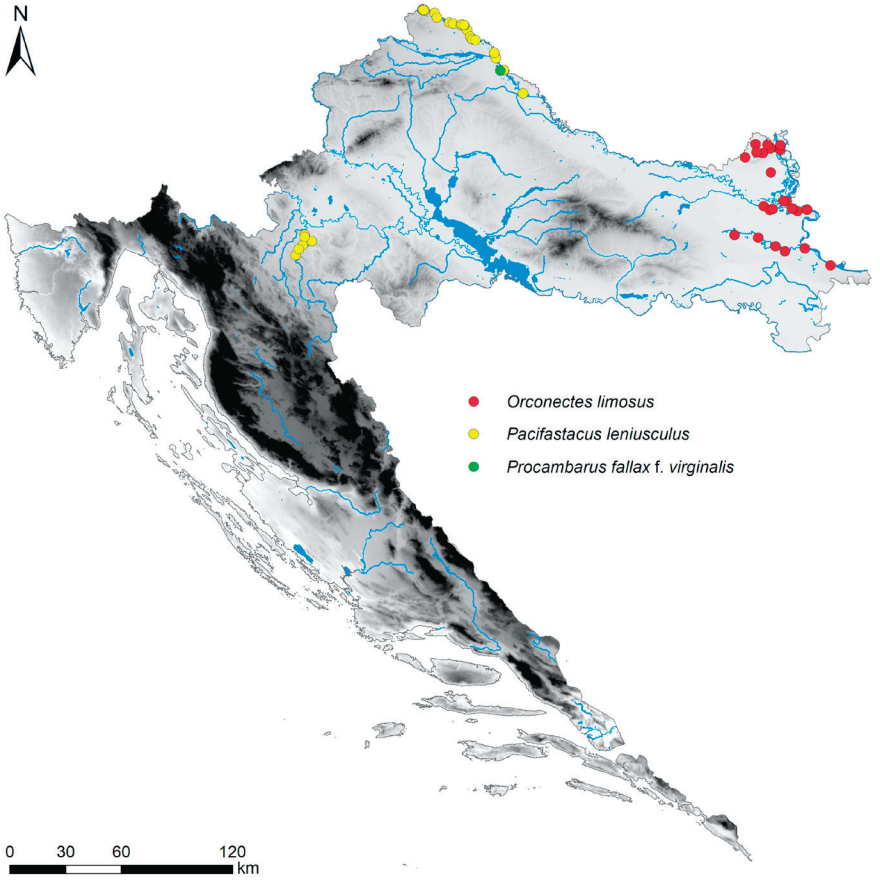

Fig. 6. Distribution of *Orconectes limosus* (Rafinesque, 1817), *Pacifastacus leniusculus* (Dana, 1852) and *Procambarus fallax* (Hagen, 1870) f. *virginalis* in Croatia.

***Pacifastacus leniusculus* (Dana, 1852) – signal crayfish (Croatian: signalni rak); Figs. 1g, 6**

The species *Pacifastacus leniusculus* has a similar appearance to that of the native noble crayfish (*Astacus astacus*), but it can be easily distinguished by its characteristic white-turquoise patch on the upper side of the chelae, smoother chelae surface, and the absence of spines on the carapace shoulders, behind cervical groove (Johnsen & Taugbøl, 2010). The total body length of adult specimens is up to 15 cm for male and 13.4 cm for female (Capurro *et al*., 2015). The signal crayfish is an omnivorous, opportunistic feeder (Turley *et al*., 2017). It inhabits a wide range of freshwater habitats (e.g. streams, rivers and lakes), but it can also survive in brackish water up to 20 ppt. salinity (Lewis, 2002).

The native range of signal crayfish is the western North American continent, from British Columbia in Canada to California in USA. However, it expanded its range within North America by human activities, and it was introduced to Japan and Europe (Lewis, 2002). Signal crayfish were brought to Sweden in 1960s to restore the important recreational and commercial crayfish fisheries, in the area where populations of native noble crayfish had been decimated by the crayfish plague. Since then, secondary introductions and natural dispersal of *P. leniusculus* in Europe continued (Johnsen & Taugbøl, 2010), despite restrictions prescribed by many governmental authorities, beginning from the late 1980s (Johnsen & Taugbøl, 2010). To date *P. leniusculus* is the most widespread alien crayfish in Europe and its presence is confirmed in 29 countries (Kouba *et al*., 2014).

The signal crayfish owes much of its invasive success to its life history strategy, such as high fecundity, early maturation, and high aggressiveness (e.g. Söderbäck, 1991; Söderbäck, 1992; Usio *et al*., 2001). In Croatia it has the advantage in competition for food and shelter over native crayfish such as *Astacus leptodactylus* (e.g. Hudina *et al*., 2016), as well as over other alien crayfish such as *Orconectes limosus* (e.g. Hudina *et al*., 2011). Like other North American crayfish species, *P. leniusculus* can also transmit the crayfish plague (Vogt, 1999) to native crayfish species. The burrowing behaviour of the signal crayfish is shown to impact the streambed physical environment (Guan, 1994; Johnson *et al*., 2010).

In Croatia *Pacifastacus leniusculus* was recorded for the first time in the Mura River in 2008, as a result of downstream spread from Slovenia (Maguire & Klobučar, 2008). Since then it expanded its range to the Drava River, with a potential to occupy water bodies in the entire Drava river catchment in northeastern Croatia (Maguire *et al*., 2011; Maguire *et al*., 2017). Additionally, in 2012 the signal crayfish was recorded in a continental karstic river, the Korana River, where it was intentionally, and illegally, introduced (Hudina *et al*., 2013; Hudina *et al*., 2017; Maguire *et al*., 2018).

***Procambarus fallax* (Hagen, 1870) f. *virginalis* – marbled crayfish (Croatian: mramorni rak); Figs. 1h, 6**

The taxon *Procambarus fallax* f. *virginalis* (the name listed on the Union list) was recently described as a separate species by Lyko (2017), and its valid taxonomic name is *Procambarus virginalis* Lyko 2017. It was originally discovered in the German aquarium pet trade (Martin *et al*., 2010a; Martin *et al*., 2010b; Martin *et al*., 2016; Lyko 2017) and considered a parthenogenetic form of the slough crayfish, *P. fallax* (Martin *et al*., 2010a; IUCN, 2018). Its morphological characteristics are marbled color pattern and small chelae. It is usually less than 10 cm long, although some individuals can grow up to 12 cm total length (Vogt *et al*., 2004; CABI, 2018g). It is closely related to *P. fallax*, which is known from peninsular Florida and southern Georgia in USA, where it occurs in

variety of lentic and lotic habitats such as forested and open wetlands, ponds, and ditches (Martin *et al*., 2010a; IUCN, 2018). However, established populations in Europe are found in lentic habitats only, such as gravel pit lakes near urban areas (Chucholl *et al*., 2012).

The main pathway of its introduction is the deliberate release of aquarium specimens (Chucholl, 2014 and references therein). This was also the presumed pathway of its introduction to Croatia (Samardžić *et al*., 2014). Since its discovery in the wild in Europe from the beginning of 2000, *P. fallax* f. *virginalis* has established populations in Germany, the Netherlands, Italy, Slovakia, Croatia, Sweden, Ukraine, and Hungary (Marzano *et al*., 2009; Chucholl *et al*., 2012; Novitsky & Son, 2016, Lőkkös *et al*., 2016).

The parthenogenetic breeding mode is not known in any other decapod crustacean (Martin *et al*., 2010a). The consequent high fecundity and extended breeding period, as well as a fast growth rate, make marbled crayfish populations difficult to control even in aquarium (Novitsky & Son, 2016). Those traits, along with a wide range of ecological tolerances, give them competitive advantages over the native crayfish species, whom they displace from their habitats (Chucholl *et al*., 2012 and references therein). They are known vectors of the crayfish plague pathogen *Aphanomyces astaci*, which can also negatively impact native crayfish species (Keller *et al*., 2014).

The first and presently only known record of marbled crayfish in Croatia is the Šoderica gravel pit lake, where an established population was found in 2014 (Samardžić *et al*., 2014; Maguire *et al*., 2018). Considering its high invasiveness and the documented negative impacts of other alien crayfish species on native crayfish, it is to be expected that the marbled crayfish will accelerate the decline of native crayfish in Croatia.

Eriocheir sinensis H. Milne-Edwards, 1853 – Chinese mitten crab (Croatian: kineska rakovica)

The species *Eriocheir sinensis* is currently not present in Croatia. However, it was found in the Serbian section of the Danube River (Škraba *et al*., 2013), so its spread to Croatian part of the Danube is likely and it is considered a door knocker species.

Freshwater fish

Two freshwater fish species of Union concern are present in Croatia: *Pseudorasbora parva* Dybowski, 1877 and *Perccottus glenii* (Temminck & Schlegel, 1846). While *P. parva* is widely distributed through freshwater systems in Croatia, *P. glenii* was found only once.

***Perccottus glenii* Dybowski, 1877 – Amur sleeper**, Chinese sleeper **(Croatian: rotan); Figs. 2a, 7**

The species *Perccottus glenii* is a small to medium sized freshwater fish species with body size up to 250 mm and weight up to 250 g. Body is covered with scales, without lateral line canals, green to gray in color, except in spawning period when males become almost completely black with green spots (Kottelat & Freyhof, 2007). It inhabits stagnant freshwater habitats such as lakes, ponds, reservoirs, gravel pits, irrigation channels and floodplains. Flowing waters (rivers, canals) are not a common habitat for *P. glenii*, but they are an important pathway for its unaided spread (long-distance corridors). *P. glenii* is not a very good swimmer, which is why they usually spread more rapidly downstream then upstream (Reshetnikov, 2013).

The native range of *P. glenii* is northeast Asia (Reshetnikov & Ficetola, 2011; Reshetnikov, 2013). The first record from Europe dates back to 1912 when it was transported to St. Petersburg province in Russia for aquarium purposes since which time it has been introduced widely across Europe and Asia. In Europe it was recorded in Russia, Belarus, Ukraine, Lithuania, Latvia, Estonia, Finland, Poland, Germany, Slovakia, Hungary, Serbia, Croatia, Bosnia and Herzegovina, Bulgaria, Romania, and Moldova (Reshetnikov & Ficetola, 2011; Reshetnikov, 2013; CABI, 2018h). The main pathway of introduction is intentional transport of live fish for aquaria. They were usually kept in garden ponds from which they could easily escape to open waters. Other pathways include intentional or unintentional translocation by local people and unaided spread through water corridors. Also, unintentional introductions through contamination of fish farming stocks (usually of *Cyprinus carpio*) are recorded (Reshetnikov & Ficetola, 2011; Reshetnikov & Schliewen, 2013; Nehring & Steinhof, 2015; CABI, 2018h). The spatio-temporal dynamics of *P. glenii* records in Eurasia confirms colonization from more than one center of invasion (Reshetnikov, 2013).

Many authors declare *P. glenii* a 'perfect conqueror' because of its reduced size, wide thermal tolerance, opportunistic diet (from ciliates to vertebrates, including fish eggs and small fish), and aggressive behavior (Koščo *et al*., 2008; Ćaleta *et al*., 2011; Luca & Ghiorghíță, 2014). Because of its high invasiveness, the lack of geographical barriers and the existence of appropriate climate conditions in Europe, as well as absence of reliable prevention methods the species has a very high risk of expansion through the Europe (Reshetnikov, 2013). It negatively affects native species through competition and predation. Decrease in relative abundance of native species, such as *Carassius carassius*, *Leucaspius delineatus*, *Rhodeus amarus,* and *Umbra krameri,* are reported for some parts of the non-native range of *P. glenii* (Reshetnikov, 2013; CABI, 2018h).

In Croatia, only one specimen of *P. glenii* has been recorded so far. This specimen was caught by an angler in the River Sava near Slavonski Brod in July 2008, in a canal connected to the carp fishpond (Ćaleta *et al*., 2011). Since then, despite the significant capture effort, no *P. glenii* has been caught in Croatia. Three hypotheses concerning the introduction of the species to the Croatian waters are proposed: (i) transfer of the fish from Hungary or Serbia to the fish ponds followed by their escape to the open waters; (ii) natural dispersal from the Danube during spring flooding and (iii) via ballast water of ships (Ćaleta *et al*., 2011). According to Piria *et al*. (2016), this species has high invasiveness potential in Croatia.

***Pseudorasbora parva* (Temminck & Schlegel, 1846) – topmouth gudgeon,** stone morroco **(Croatian: bezribica,** amurski čebačok**); Figs. 2b, 7**

The species *Pseudorasbora parva* is the only representative of the fish genus *Pseudorasbora* known in Europe. The body is up to 110 mm long, greenish gray or silver in color. During spawning period males develop bluish or purple-gray coloration and nuptial tubercles on snout (Kottelat & Freyhof, 2007). Mouth is small and superior, without barbels. The species inhabits a wide variety of habitats, but it is most abundant in shallow, densely vegetated ponds, small lakes, and canals, where the female lays eggs on vegetation. Females have high fecundity and spawn multiple times in season, while males guard nests until fry is hatched (Kottelat & Freyhof, 2007). It is an opportunistic omnivore, feeding on algae, plant material, zooplankton, insects, crustaceans, fish eggs, and small fish (Yalçın-Özdilek *et al*., 2013).

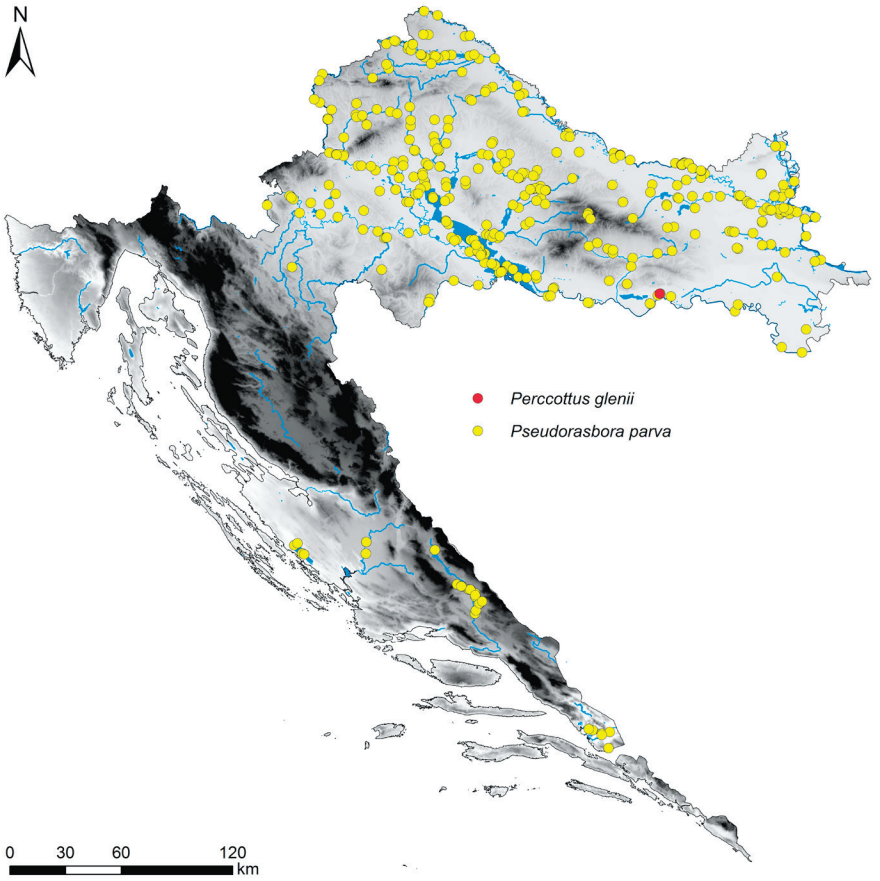

Fig. 7. Distribution of *Perccottus glenii* (Temminck & Schlegel, 1846) and *Pseudorasbora parva* Dybowski, 1877 in Croatia

Its native range is northeastern Asia, from the river Amur to the Pearl River drainages in Siberia, Korea, China, and Japan but has been widely introduced to various areas in Asia and Europe (Kottelat & Freyhof, 2007; CABI, 2018i). The introduction to the European waters was accidental – the species was unintentionally shipped from China along with the herbivorous Chinese carp fry to the fish farms in Europe (Romania, Lithuania, Hungary and Ukraine) in the early 1960s (Welcomme, 1988; Golzan *et al*., 2010; Witkowski, 2011). Since its initial introduction, it invaded almost all countries in Europe as stock contaminant, through intentional introduction as ornamental fish or fish bait, and through secondary spread to new areas. It is especially abundant in Eastern Europe, from Danube to Kuban drainages, east to Volga and south to central Iran (Kottelat & Freyhof, 2007).

Strong negative effects of *P. parva* on habitats and species have been recorded (Witkowski, 2011). When in high densities, it competes with other species for food. Through predation on larger zooplankton it increases phytoplankton densities and, subsequent-

ly, increases eutrophication of water. Also, it can actively predate upon fish eggs and fry of native species, reducing their abundance. It is also a vector of several parasites representing a threat to native and farmed fish species (Witkowski, 2011).

The species *P. parva* was noticed in mid 1980s in Croatia (Tvrtković, 1985; Habeković & Popović, 1991) where it was probably introduced through fish farming stocks or by unaided spread from rivers in the Danubian basin. The species is currently distributed throughout the entire country in waters of both the Adriatic and the Danubian drainages. In Croatia, it occurs in high abundance in adequate habitats, especially in waters belonging to Danubian drainage and near fish farms. According to Piria *et al*. (2016), it has medium high invasiveness potential in Croatia.

Reptiles

Only one invasive alien reptile species of Union concern is present in Croatia – *Trachemys scripta* (Schoepff, 1792).

***Trachemys scripta* (Schoepff, 1792) – pond slider**, common slider **(Croatian: crvenouha kornjača (*T. s. elegans*), žutouha kornjača (*T. s. scripta*)); Figs. 2c, 8**

The species *Trachemys scripta* is medium sized terrapin with carapace length up to 280 mm (Bringsøe, 2006). Coloration of carapace and skin is olive to brown with yellow stripes and spots. It has yellow or red patches on each side of the head (Bringsøe, 2006; CABI, 2018j). The species is a freshwater habitat generalist but prefers larger, stagnant, well vegetated water bodies with soft bottoms and suitable basking sites (Bringsøe, 2006).

The native range of the pond slider includes the southeastern United States and northeastern Mexico, where species is represented with three subspecies – *T. s. scripta, T. s. elegans*, and *T. s. troostii*. Because they are among the most popular pet animals, non-native distribution of pond sliders is almost the whole of the world, including almost all European coutries (Bringsøe, 2006; Jelić & Jelić, 2015; CABI, 2018j).

The main pathway of introduction of *T. scripta* worldwide is pet release into semi-natural and natural habitats. The most popular subspecies in pet trade is *T. s. elegans*, which was in the aquarium trade market in massive numbers from the 1970s. After bans on selling this particular subspecies in Europe in 1997 (EC, 1997), it was replaced either with other subspecies (usually *T. s. scripta*) or other similar species of terrapin (Bringsøe, 2006; CABI, 2018j). Records of *T. scripta* in natural habitats in Europe date back to the 1980s (Bringsøe, 2006), while its first official record in Croatia is from 1999 from a pond near Grubišno polje (Jelić & Jelić, 2015; Jelić *et al*., 2016). Since then many individuals were recorded in Croatia, usually in ponds and lakes in public parks (Koren *et al*., 2018). The largest known population of *T. scripta* in Croatia, with around 300 individuals, is in Maksimir park's ponds in Zagreb (Jelić & Jelić, 2015; Jelić *et al*., 2016). Despite some indications that it is unable to reproduce in the wild in Europe, records of egg-laying females and young individuals (probably hatchlings) were recorded on several occasions in Croatia and countries with similar climate (Serbia, Spain) indicating that climate conditions in Croatia are suitable for its successful reproduction (Perez-Santigosa *et al*., 2008; Đorđević & Anđelković, 2015; Schweiger, 2015; Jelić *et al*., 2016). Taking this into account, it is likely that *T. scripta* has established in Croatia. Because of its negative impact on native species through competition (with native *Emys orbicularis* and *Mauremys rivulata*), predation and potential disease transmission, it is considered invasive in Croatia. It can impact human health through possible transmission of human salmonellosis (Nagano *et al*., 2006; Lafuente *et al*., 2013).

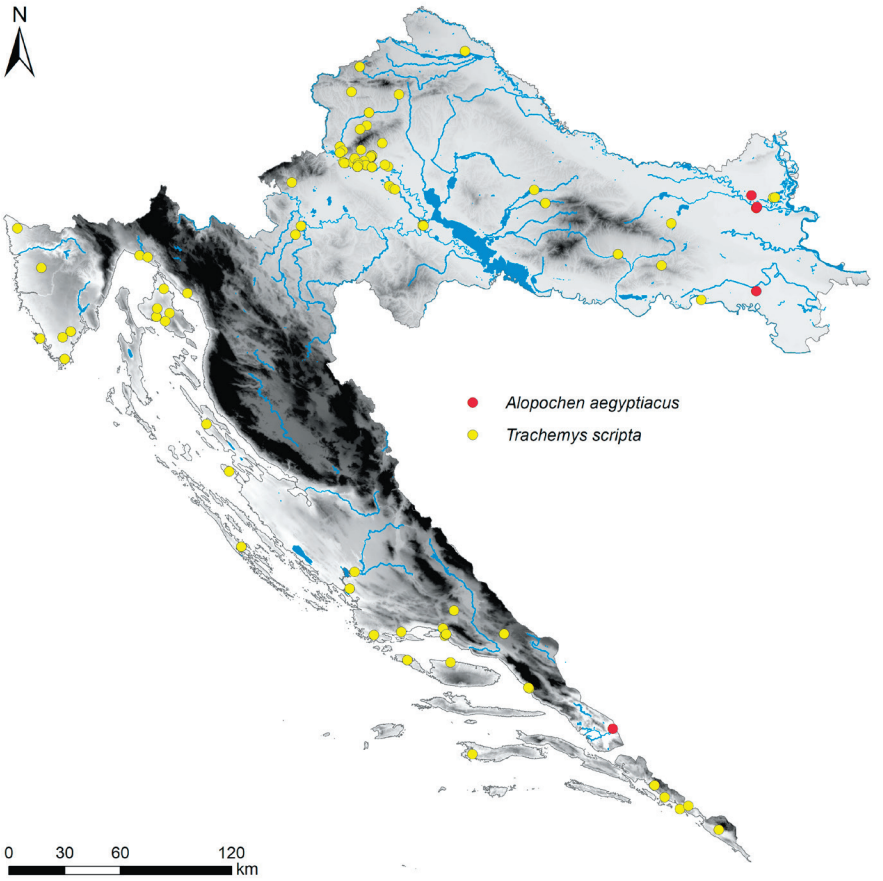

Fig. 8. Distribution of *Trachemys scripta* (Schoepff, 1792) and *Alopochen aegyptiacus* (Linnaeus, 1766) in Croatia.

Amphibians

Lithobates catesbeianus (Shaw, 1802) – American bullfrog (Croatian: sjevernoamerička žaba bukača)

The status of the amphibian species *Lithobates catesbeianus* in Croatia is currently uncertain. There is one literature record of the American bullfrog in Croatia (Janev-Hutinec *et al*., 2006), but published data about time or place of this record are lacking. Most likely, the species was introduced as a stock contaminant in one fish farm near Karlovac before 2006 (Burić *et al*. 2018, N. Tvrtković, pers. comm.), but further confirmation is necessary. Recently it was found in Slovenia near the border with Croatia (Kirbiš *et al*., 2016). Because of climate and habitat suitability and the proximity of the recent finding in Slovenia it can be considered a door knocker species for Croatia.

Birds

In Croatia only one invasive alien bird species of Union concern is present – *Alopochen aegyptiacus* (Linnaeus, 1766).

***Alopochen aegyptiacus* (Linnaeus, 1766) – Egyptian goose (Croatian: egipatska guska); Figs. 2d, 8**

The species *Alopochen aegyptiacus* is the only representative of the bird genus *Alopochen* (family *Anatidae*). It has pink legs and bill, dark brown upper wings and head, a dark patch around eyes and in the middle of chest, while the rest of the plumage is light brown (Heinzel *et al*., 1995; Gyimesi & Lensink, 2010). It is mainly a bird of large rivers and floodplains, but it can inhabit a broad range of wetland habitats, such as ponds, lakes, swamps, estuaries, and wet meadows (Scott & Rose, 1996; Callaghan, 2016). Its diet includes grass, aquatic vegetation, seeds, and a wide range of agricultural crops (Halse, 1984; Callaghan, 2016). It can nest on the ground, under the vegetation, in trees, cliffs, and in caves, as well as in buildings and houses (Pitman, 1965).

It is native to sub-Saharan Africa, where it is one of the most common and widespread waterfowl (Smith, 2012; Callaghan, 2016). It was introduced to Great Britain at the end of 17th century as an ornamental waterbird, and it had become established in the wild by the 18th century (Lever, 2005). On the continent, a breeding population was first observed in the Netherlands near The Hague in 1967 (Lensink, 1999). The Egyptian goose is a highly territorial and adaptable species. It is currently established and widely distributed in Great Britain, Belgium, the Netherlands, Germany, and France (Banks *et al*., 2008), and is considered one of the most rapidly spreading invasive species in Europe (Lensink, 1999; Smith, 2012; Callaghan, 2016).

It is considered a serious agricultural pest throughout its native range, especially of cereal crops (Mangal & Crowe, 2002; Gyimesi & Lensink, 2010). The species can negatively impact native bird species through competition for food and nesting sites (Gyimesi & Lensink, 2010) and through hybridization with other geese (e. g. *Branta canadensis* and *Anser anser*) or ducks (e. g. *Anas platyrhynchos*; Banks *et al*., 2008), although the hybrids are usually sterile (Homma & Geiter, 2010). Furthermore, if population density is high, the large amounts of the bird's faeces can cause the eutrophication of freshwater habitats, and the birds can be a threat to aircraft safety if they live and fly near airports (Lensink *et al*., 2010). They are also a known vector of avian influenza (Shihmanter *et al*., 1998).

In Croatia it was recorded near Slavonski Brod (Kralj, 2013), Darda, Metković and Osijek (Barišić *et al*., 2016). The data about established populations in Croatia do not exist.

Mammals

Five invasive alien mammal species of Union concern are currently known for Croatia: *Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818), *Myocastor coypus* (Molina, 1782), *Nyctereutes procyonoides* (Gray, 1834), *Ondatra zibethicus* (Linnaeus, 1766), and *Procyon lotor* (Linnaeus, 1758).

***Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818)* – small Indian mongoose**, small Asian mongoose, Javan mongoose, Indian mongoose **(Croatian: mali indijski mungos); Figs. 2e, 9**

* The name *Herpestes javanicus* on the Union list refers to the subspecies introduced to Croatia, *H. j. auropunctatus*, which is by some authors considered a separate species *H. auropunctatus*, see Taxonomic notes below

The small Indian mongoose (*H. j. auropunctatus*; see Taxonomic notes below) is the smallest of all Asian *Herpestes* species. It has a slender body with short legs and robustly muscular tail. The head is elongated with a pointed muzzle and short ears. Feet are pentadactyl with long sharp non-retractile claws. Fur is short and soft, pale to dark brown, and flecked with golden spots (Nellis, 1989). Males have a longer and more robust body and wider head than females (Nellis, 1989). Adult body mass ranges from 300 to 900 g (Hays & Conant, 2007). Mongooses are generalist feeders whose diet changes seasonally and locally (Simberloff *et al*., 2000). They are diurnal and terrestrial animals - they can swim and climb trees but they will avoid water whenever possible, they reduce their activity during rainy periods and will not voluntarily enter water deeper than 5 cm (Nellis & Everard, 1983). They can live in various habitats such as forests, grasslands, wetlands, deserts, and coastal and riparian zones, as well as in agricultural areas, landfills, ruderal and urban areas (Nellis & Everard, 1983; GISD, 2018).

The small Indian mongoose is native to the Middle East and much of South and Southeast Asia (Nellis, 1989). It was intentionally introduced more widely than any other mammal (Hays & Conant, 2007). It was successfully introduced to at least 64 islands in the Pacific and Indian Oceans and the Caribbean and Adriatic Sea, and to the continental South America and Europe, however introductions to North America and Australia were unsuccessful (Barun *et al*., 2011a). All documented introductions of this species were intentional, because of its reputation as a control agent for rats and snakes. Unfortunately, it is also an efficient predator of many endangered and threatened vertebrates (Hays & Conant, 2007).

The small Indian mongoose was first introduced to Croatia in 1910 to the island of Mljet for control of the poisonous horned viper (*Vipera ammodytes*) populations, when seven males and four females from India were released. As a consequence, the native horned viper has been extinct on Mljet since World War II (Tvrtković & Kryštufek, 1990). It was subsequently successfully introduced to several nearby islands: Korčula (in 1921), Hvar (ca 1970s), Čiovo (ca 1950s), Škrda near Pag Island (ca 1950s), Hvar (ca 1970s), and Kobrava near Mljet Island (Tvrtković & Kryštufek, 1990; Kryštufek & Tvrtković, 1992; Barun *et al*., 2008; Barun, 2011), as well as on the islets of Moračnik, Ovrata and Tajnik near Mljet Island (Selanec *et al*., 2016). It was also unsuccesfully introduced to the island of Brač (in 1926) (Tvrtković & Kryštufek, 1990). It was introduced to Pelješac Peninsula repeatedly from 1921 to 1927 (Tvrtković & Kryštufek, 1990). Since then it spread along the southern Dalmatian and Montenegro coast up to Neretva River in the Bosnia and Herzegovina in the north and Albania in the south (Barun *et al*., 2011b; Ćirović *et al*., 2011, Ćirović & Toholj, 2015). At present, the European range of the species includes the Adriatic coast (Fig. 9) from the island of Škrda and the Neretva River in the north, to Albania in the south (Gaubert, 2016).

The small Indian mongoose is a generalist predator causing the decline and extirpation of native mammals, birds, reptiles, and amphibians on islands (Lowe *et al*., 2000; Barun, 2011). On Croatian islands it is harmful to the wild fowl and it damages vegetables, figs, grapes as well as poultry (Tvrtković & Kryštufek, 1990). Additionally, it carries human and animal diseases, including rabies and human *Leptospira* bacterium (Pimentel, 1955; Nellis & Everard, 1983). Contrary to what might be expected, the residents on the island of Mljet like the mongoose and they do not see it as a pest. Furthermore, it is considered a tourist attraction (Gjurašić *et al*., 2014).

Taxonomic notes

The taxonomy of *H. javanicus* is unclear and often debated. From 1940s some authors considered *Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818) and *Herpestes auropunctatus* (Hodgson, 1836) separate species, while others considered it a single species, *H. javanicus*, with *H. j. auropunctatus* as one of the subspecies (for more details see Veron *et al*., 2007). In recent molecular studies (Veron *et al*., 2007; Patou *et al*., 2009; Veron & Jennings, 2017) phylogenetic analyses showed that *H. javanicus*, *H. auropunctatus*, and their closest relative, the sympatric *H. edwardsii* (É. Geoffroy Saint-Hilaire, 1818), are molecularly distinct clades (although with unclear relationships among them). Separation of *H. auropunctatus* from *H. javanicus* is supported by morphological evidence according to some authors (Taylor & Matheson, 1999), while others consider this an intraspecific size variation due to competition or the lack of it (Simberloff, 2000).

The name used on the Union list refers to the subspecies *H. javanicus auropunctatus*, commonly called the small Indian mongoose. The small Indian mongoose is found from the Arabian Peninsula across the northern Indian subcontinent to Southeast Asia (Gilchrist *et al*., 2009), and this is the taxon (either species or subspecies) that was introduced at the end of the 19th and during the 20th century to many different parts of

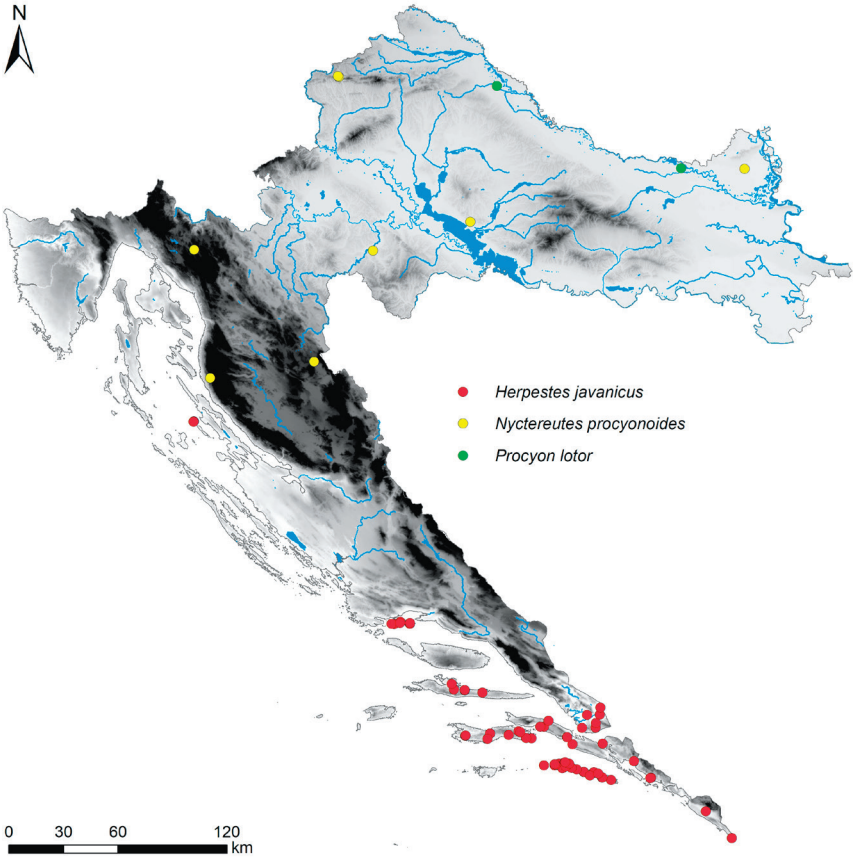

Fig. 9. Distribution of *Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818), *Nyctereutes procyonoides* (Gray, 1834), and *Procyon lotor* (Linnaeus, 1758) in Croatia.

the world (mainly on islands) for the biological control of rats and snakes in plantations (Tvrtkovic & Kryštufek, 1990; Simberloff *et al*., 2000; Barun, 2011; Veron & Jennings, 2017). The remaining populations (or separate species *H. javanicus*) are geographically separate from the small Indian mongoose, occurring from Java through Sumatra and mainland South-east Asia.

***Myocastor coypus* (Molina, 1782) – coypu (Croatian: nutrija); Figs. 2f, 10**

The species *Myocastor coypus* is a rat-like semiaquatic rodent, the only member of the genus *Myocastor* (Woods *et al*., 1992). It has a robust body, covered with light to dark brown dense fur, and bright orange incisor teeth. The average body length, not including the tail, is 52 centimeters. Its tail is long (average 37 cm), rounded, and covered with sparse hairs, which distinguishes it from beavers and muskrats. It was traditionally classified as the only member of the family Myocastoridae, with unclear relatedness to other rodent taxa (Woods *et al*., 1992), but recent molecular phylogenetic analyses revealed it belongs to the family Echimyidae, South American spiny rats (Fabre *et al*., 2013; Loss *et al*., 2014). Coypu inhabits waterways, marshes, rivers, lakes, and prefers sites with an abundance of emergent aquatic plants, their main food source. They can also occasionally feed on invertebrates, such as freshwater mussels (Baroch *et al*., 2002; Kume *et al*., 2012), and on eggs of ground nesting birds (Windhoffer, 2017). They are nocturnal, but they can become diurnal during the cold periods (Woods *et al*., 1992). They construct 1-6 meter long burrows in banks near the water, sometimes with several entrances.

The species is native to the southern half of South America and is introduced worldwide (Woods *et al*., 1992). Extensive fur farming of coypu was established in Europe and North America in the first half of the 20th century, and since then it was introduced to many countries in Europe, Asia, Africa, and North America, often establishing in the wild (Woods *et al*., 1992; Carter & Leonard, 2002). The main pathway of introduction is intentional or accidental release from fur farms. Occasionally they were also released for the biological control of water weeds (Carter & Leonard, 2002).

In the non-native habitats it can reach very high population densities. Main impacts are destruction of marsh habitats by feeding on native vegetation and disruption of irrigation systems due to the burrowing activities in the river banks and ditches (Woods *et al*., 1992; Carter *et al*., 1999; Carter & Leonard, 2002). It can cause damage to agriculture by feeding on crops (Linscombe & Kinler, 1997; Guichón *et al*., 2003) and will decrease water bird populations by nest disturbance (Bertolino *et al*., 2011; Angelici *et al*., 2012). Also, it can transmit parasites and disease to livestock, wildlife, and humans (Gebhardt, 1996; Moutou, 1997; Michel *et al*., 2001; Fratini *et al*., 2015).

In Croatia the coypu was first found in 1936, in marshland near Donja Dubrava, Međimurje (Hirtz, 1937a). The species was introduced to Croatia by spread from neighbouring countries (Slovenia, Hungary or Austria), where it was released or escaped from the fur farms. An established population in the Mirna river valley in Istria was known prior to 1989 (Purger & Kryštufek, 1991), and recent records also include the river basins of the Sava, Drava, and Kupa rivers (Fig. 9). According to the Animal Protection Act (Anonymous, 2017) fur farming is prohibited in Croatia, so currently the only pathway for introduction to new habitats is the unaided spread of the population. Its eradication has been allowed in the Mirna valley since 2008, but the population established there has not been completely eradicated. In other countries complete eradication was shown to be less costly than long-term population control (Gosling *et al*., 1988; Panzacchi *et al*., 2007). Known impacts of *M. coypus* in Croatia are destruction of native vegetation and damage of river banks and irrigation systems.

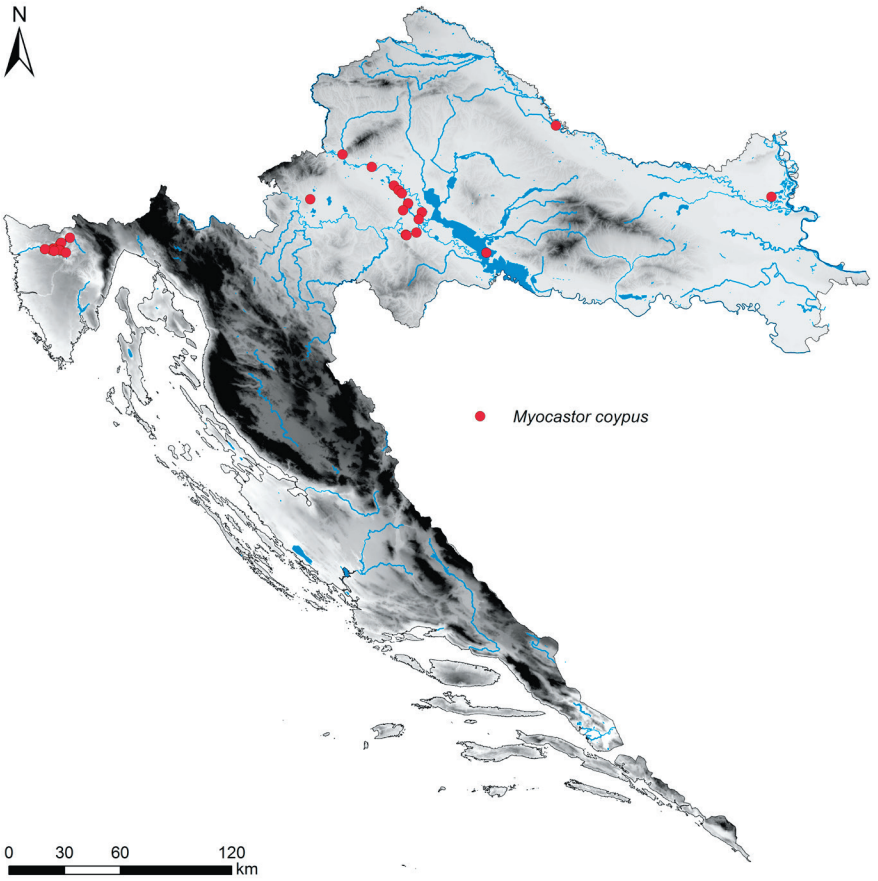

Fig. 10. Distribution of *Myocastor coypus* (Molina, 1782) in Croatia.

***Nyctereutes procyonoides* (Gray, 1834) – raccoon dog (Croatian: rakunopas,** kunopas**); Figs. 2g, 9**

The species *Nyctereutes procyonoides* is a member of the Canidae family, about the size of a small fox (body length 57-71 cm) but with shorter legs, with thick, long and dense fur, light grey to black in color, and with a distinct black mask around the eyes (Ward & Wurster-Hill, 1990). It inhabits variety of habitats, from meadows and forests with dense undergrowth to mosaic of agricultural land, and is often found near the water (Kauhala, 1996).

Originally from Eastern Asia it was brought to Europe for fur production. An exceptionally large number of individuals (9100 animals) were introduced between 1929 and 1955 to multiple locations in the European part of the former Soviet Union and were often deliberately released from fur farms (Kauhala & Kowalczyk, 2011). They became established in the wild and dispersed rapidly across northern and eastern Europe (Kowalczyk, 2006; Kauhala & Kowalczyk, 2011). Today they are established in Belarus, Bulgaria, Estonia, Finland, Germany, Latvia, Lithuania, and Poland (CABI, 2018k). The success of their establishment and spread in non-native range is attributa-

ble to the high genetic variability of introduced population, high reproductive capacity, its ability to hibernate during the winter in the cold climates, an opportunistic diet, and high dispersal ability (Sutor *et al.*, 2010; Kauhala & Kowalczyk, 2011).

The severity of its impact on the native ecosystems is somewhat controversial because of a small number of studies experimentally demonstrating clear effects (CABI, 2018k). When their population is dense it negatively impacts, through direct predation, native birds, amphibians, reptiles, and small mammals; while native carnivores are affected through competition (Kowalczyk, 2006; Sutor *et al.*, 2010; Kauhala & Kowalczyk, 2012). Furthermore, it impacts wild and domesticated animals through the transmission of rabies (Kowalczyk, 2006; Singer *et al.*, 2009) and parasites (Oksanen *et al.*, 1998; Oivanen *et al.*, 2002).

In Croatia, most likely pathway of introduction was migration from neighboring countries, from Serbia, Hungary, and Slovenia (Ćirović & Milenković, 1999; Kauhala & Kowalczyk, 2011; Budinski *et al.*, 2018). The individual records (Fig. 9) are scattered across Croatia and they include Baranja (Pavlović, 1994, cited by Ćirović & Milenković, 1999), the Dinarides near Mrkopalj (Duplić *et al.*, 2016), Plitvice Lakes National Park (N. Magdić, pers. comm.), and Northern Velebit area (Šver *et al.*, 2018). This is probably a reflection of the species' high dispersal capacity, but the presence of established populations is not confirmed. No data about the impact of the raccoon dog on native species and habitats exist for Croatia.

***Ondatra zibethicus* (Linnaeus, 1766) – muskrat (Croatian: bizamski štakor); Figs. 2h, 11**

The species *Ondatra zibethicus* is a semiaquatic rodent, similar to *Myocastor coypus* but smaller, with 45-55 cm average body length, including a long, hairless, laterally flattened tail (Willner *et al.*, 1980). The species is the only representative of the genus *Ondatra* (family Cricetidae) (Steppan & Schenk, 2017). It inhabits marshes, lakes, ponds, and other slow moving waters, including brackish and saline systems, but prefers eutrophic waters with plenty of vegetation (Willner *et al.*, 1980; Smirnov & Tretyakov, 1998). For their nesting site muskrats excavate burrows in the banks and construct lodges in the water out of plant material, with one or several chambers above the water level. In most cases, they use burrows in summer and lodges during winter (CABI, 2018l).

The native range of *O. zibethicus* covers most of North America. They were brought over to Europe in 1905 for fur farming, where they quickly established in many countries, thanks to their high reproduction rate, good dispersal ability, and wide climatic tolerance (Skyriene & Paulauskas, 2012; CABI, 2018l). Muskrat fur farms do not exist anymore in Europe, so the only current introduction pathway to the new areas is secondary unaided dispersal. Within Europe it has established populations in Austria, Belgium, the Czech Republic, Finland, France, Germany, Hungary, the Netherlands, Poland, Russia, Sweden, Switzerland, and Bosnia and Hercegovina (Skyrienė & Paulauskas, 2012; CABI, 2018l). It was successfully eradicated from the United Kingdom and Ireland (Danell, 1996).

Large populations of *O. zibethicus* can damage river banks and flood dikes with their burrowing activities, and diminish aquatic plant communities by grazing, which also causes the loss of nursery sites for fishes (Skyrienė & Paulauskas, 2012). Muskrats predate on freshwater bivalves and crustaceans which can cause their population to decline, occasionally damage agricultural crops, and can have negative impact on na-

tive semi-aquatic rodent populations because of competition for resources (Gebhardt, 1996; Owen *et al.*, 2011; Skyrienė & Paulauskas, 2012; Birnbaum, 2013).

The muskrat was first found in Croatia in 1932 (Dolenec, 1934), introduced from Hungary and Austria by dispersal down the Mura River (Plančić, 1937), and since then it has spread across the country (Fig. 11), in the majority of the large rivers: Danube, Sava, Kupa, Drava, and Krka (Kaman, 1950; Savić, 1962; De Luca *et al.*, 1989). Despite its long presence in Croatia there are no recent studies of its population density and size, or its ecological impact.

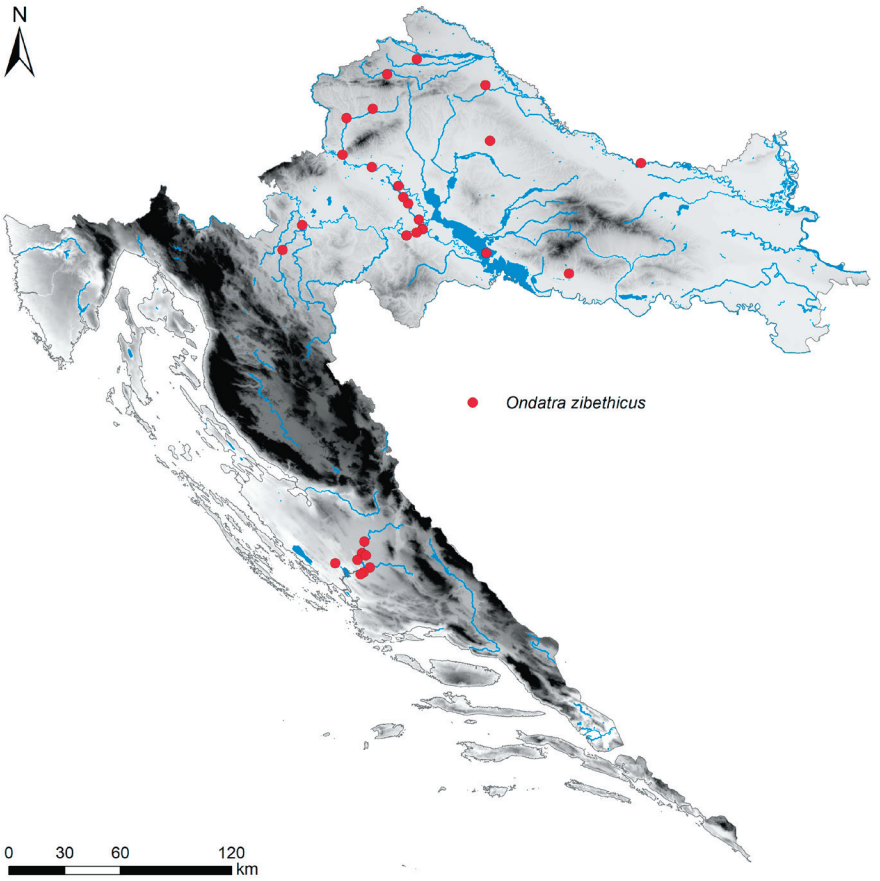

Fig. 11. Distribution of *Ondatra zibethicus* (Linnaeus, 1766) in Croatia.

***Procyon lotor* (Linnaeus, 1758) – raccoon (Croatian: rakun); Figs. 2i, 9**

The species *Procyon lotor* is a medium sized carnivore, a member of family *Procyonidae* (Lotze & Anderson, 1979), readily recognized by its brown to black mask around eyes, delimited with lighter, white-grey fur. The remainder of its coat is iron grey, varying to almost black or reddish, with lighter fur on legs, flanks, and tips of ears. Its tail is bushy and has five to seven characteristic white rings. Its feet have five digits each, with short claws, but no webbing. It is capable of using its front paws for grasping and manipulating objects (Lotze & Anderson, 1979; Bartoszewicz, 2011). It eats a

wide variety of plants and invertebrates (crabs, crayfish, molluscs), and predates on vertebrates, such as birds, turtles, mammals, and their eggs or young (Biedrzycka, 2014). In urban habitats and in the absence of other food it will eat food remains from trash and cause damage in gardens and agricultural fields, which is why it is considered nuisance and pest in many cities (Gehrt, 2004).

Its native distribution ranges from southern Canada to Central America (Garcia, 2012). In Europe, it was introduced to central Germany between 1927 and 1934. During the late 1960s, following the intentional release of an unknown number of individuals, it established in northern France (Bartoszewicz, 2006). It was also introduced to several locations in Russia and Belarus during the 1950s, but only a few populations succeeded in establishing there. The main pathways for raccoon introduction were intentional or accidental release from fur farms and intentional release for hunting, and more recently escapes of pet animals (Zalewski, 2011). Because of its high plasticity in habitat selection and generalist diet it is now widely distributed throughout most of Central Europe, with large populations in some areas. For example, in Germany the population is estimated from 100,000 to one million raccoons (Zalewski, 2011). Currently, in Europe the species is known for Austria, Belgium, the Czech Republic, Denmark, Great Britain, Hungary, Italy, Lithuania, Luxembourg, Liechtenstein, Montenegro, the Netherlands, Norway, Poland, Slovenia, Serbia, Slovakia, Sweden, and Switzerland (Canova & Rossi, 2008; CABI, 2018m).

In both the native and introduced range it causes major economic losses in urban areas by damaging fruit trees and garden crops, causing structural damage to houses, and damaging crops in the fields (Ikeda *et al.*, 2004). It can negatively impact native bird fauna through egg predation, especially of waterfowls and larids (Hartman *et al*., 1997; Hartman & Eastman, 1999; Ellis *et al*., 2007). Through both predation and competition it also impacts native mammals (Ikeda *et al*., 2004; Zalewski, 2011), and it is a known vector of diseases and parasites for native fauna, domestic animals, and humans (Garcia, 2012).

In Croatia it was recorded recently at only two localities (Fig. 9): Podravski Podgajci (Bogdanovic, 2014) and Hlebine (K. Krapinec, pers. comm.). However, it was first recorded in 1937 when one individual was killed by a train in Stenjevec near Zagreb (Hirtz, 1937b). Considering its rare occurrence it is probably a casual species at this moment. No data about its impact on native species and habitats for Croatia exist.

CONCLUSION

Currently there are 49 invasive alien plant and animal species included on the Union list, out of which 17 species are present in Croatia. Three other plant species on the Union list might be present in cultivation, and two animal species are considered door knocker species in Croatia. While some of the present species are known only from one or few localities, others are widely distributed in Croatia. Depending on their presence and distribution, Regulation 1143/2014 prescibes prevention, early detection, rapid eradication or management. Therefore, for successful combat against invasive alien species of Union concern in Croatia, in order to prevent or mitigate their adverse impact, extensive work will be needed in the future, with the cooperation and concerted action of many other sectors (e. g. forestry, agriculture, fisheries, water management, customs).

ACKNOWLEDGEMENTS

The data used in this paper were partly obtained through the project "Establishment of the National Monitoring System for Invasive Alien Species in Croatia" financed by EU Cohesion Fund in the framework of Operational Programme Competitiveness and Cohesion 2014 - 2020. We would like to thank our colleagues who allowed us to use their photos: Matija Franković for a photo of the small Indian mongoose, Sandra Hudina for a photo of *Orconectes limosus*, Luka Katušić for a photo of *Pacifastacus leniusculus*, Aleksandra Kočić for photo of *Elodea nuttallii*, Perica Mustafić for photos of *Pseudorasbora parva* and *Perccottus glenii* and Miroslav Samardžić for a photo of *Procambarus fallax* f. *virginalis*. We would also like to thank our colleague Stjepan Mekinić for providing his field data on *Trachemys scripta* in Split-Dalmatia County and the reviewers for improving our manuscript.

Received September 19, 2018

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SAŽETAK

Invazivne strane vrste koje izazivaju zabrinutost u Uniji (Uredba 1143/2014) prisutne u Hrvatskoj

I. Boršić, A. Ješovnik, T. Mihinjač, P. Kutleša, S. Slivar, M. Cigrovski Mustafić & S. Desnica

Uredba 1143/2014 o sprječavanju i upravljanju unošenja i širenja invazivnih stranih vrsta određuje okvir za sprječavanje, svođenje na najmanju moguću mjeru i ublažavanje štetnih učinaka invazivnih stranih vrsta na bioraznolikost u Europskoj uniji. Iako je Uredba obvezujuća i mora se u cijelosti primjenjivati u svim državama članicama, njezina implementacija u Hrvatskoj osigurava se Zakonom o sprječavanju unošenja i širenja stranih te invazivnih stranih vrsta i upravljanju njima („Narodne novine", br. 15/18).

Uredba se odnosi na invazivne strane vrste u Europskoj uniji te se sukladno Uredbi donosi popis invazivnih stranih vrsta koje izazivaju zabrinutost u Uniji ("Unijin popis"). Prvi popis donesen je Provedbenom uredbom Komisije 2016/1141 i uključivao je 37 vrsta. Dodatnih 12 vrsta dodano je na Unijin popis Provedbenom uredbom Komisije 2017/1263. Od tih 49 vrsta, 17 vrsta prisutno je u Hrvatskoj. One uključuju pet biljaka (Plantae): *Asclepias syriaca* L., *Elodea nuttallii* (Planch.) St. John, *Heracleum mantegazzianum* Sommier & Levier, *Impatiens glandulifera* Royle i *Myriophyllum heterophyllum* Michaux.; tri raka (Crustacea): *Orconectes limosus* (Rafinesque, 1817), *Pacifastacus leniusculus* (Dana, 1852) i *Procambarus fallax* (Hagen, 1870) f. *virginalis*; dvije slatkovodne ribe (Actinopterygii): *Perccottus glenii* (Temminck & Schlegel, 1846) i *Pseudorasbora parva* Dybowski, 1877: jednog gmaza (Reptilia): *Trachemys scripta* (Schoepff, 1792); jednu pticu (Aves): *Alopochen aegyptiacus* (Linnaeus, 1766); i pet sisavaca (Mammalia): *Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818), *Myocastor coypus* (Molina, 1782), *Nyctereutes procyonoides* (Gray, 1834), *Ondatra zibethicus* (Linnaeus, 1766) i *Procyon lotor* (Linnaeus, 1758).

Dodatno, tri biljne vrste s Unijinog popisa ne nalaze se na popisu flore Hrvatske, niti su prema našem saznanjima prisutne u prirodi, ali je moguće da su u Hrvatskoj prisutne kao ukrasne biljke u uzgoju. To su: *Eichhornia crassipes* (Martius) Solms, *Ludwigia peploides* (Kunth) P.H. Raven i *Pennisetum setaceum* (Forssk.) Chiov. Dvije dodatne životinjske vrste s Unijinog popisa koje u radu spominjemo su *Eriocheir sinensis* (Malacostraca) i *Lithobates catesbeianus* (Amphibia). One su prisutne u susjednim zemljama te su zabilježene i u blizini hrvatske granice, pa je njihov unos u budućnosti vjerojatan.

U radu predstavljamo sistematiku i biologiju vrsta s Unijinog popisa prisutnih u Hrvatskoj, prirodno područje rasprostranjenosti, područje unosa, povijest unosa, putove njihovog unosa u Hrvatsku, utjecaj u unesenom području, uključujući i poznate utjecaje u Hrvatskoj. Također, temeljem dostupnih podataka prikazujemo njihovu rasprostranjenost u Hrvatskoj.

Neke od vrsta s Unijinog popisa prisutne u Hrvatskoj poznate su samo s jednog ili nekoliko nalazišta, dok su druge široko rasprostranjene. Ovisno o njihovoj prisutnosti u Hrvatskoj odnosno njihovoj rasprostranjenosti, Uredba propisuje prevenciju, rano otkrivanje i brzo iskorjenjivanje, ili upravljanje. Dakle, za uspješnu borbu protiv invazivnih stranih vrsta koje izazivaju zabrinutost u Uniji prisutnih u Hrvatskoj, a kako bi se spriječio ili ublažio njihov štetan učinak, bit će potrebni znatni napori, uz suradnju i usklađeno djelovanje s ostalim sektorima (npr. šumarstvo, poljoprivreda, ribarstvo, upravljanje vodama, granična kontrola).