



The Updated List of the Non-Native Freshwater Fishes in Slovenia with Note of their Potential Impact in Inland Waters

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ABSTRACT

In this paper up-to-date information on the known introductions of non-native fish species in Slovenia are summarized. Since the last report of list of alien fish species in Slovenia, two new introduced species has been recorded, which makes 22 new fish species in total. New species was introduced accidentally, by natural range expansion and by aquaculture. The date of introduction to Slovenia, the reason for the introduction, the mode of recent expansion, the degree of acclimatization and potential impacts on newly introduced non-native fishes were presented. Moreover, measures for the prevention of the uncontrolled restocking and further dispersal of alien freshwater fish species are proposed.

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Authors' Contribution

M Povz designed the study and prepared the manuscript. GJ and M Piria analyzed and interpreted the data and finalized the article.

Key words

Alien freshwater fish species, Introductions, Open waters, Slovenia.

INTRODUCTION

Biological invasions are recognized as a major threat to biodiversity and their impacts in freshwater environments are of particular concern (Dudgeon *et al.*, 2006). Introductions of invasive freshwater alien species (IAS) are a significant and growing problem worldwide, including in Slovenia. The ichthyofauna of Slovenian inland waters is represented by 97 fish species, of which 28% are endemic (Povž *et al.*, 2015). Recent data show that alien fish introductions are a major threat to the native ichthyofauna in the region (Mrakovčić *et al.*, 2006), particularly to the endemic species (Čaleta *et al.*, 2015).

Until 2005, in Slovenia, 16 fish species was introduced and, between them, 10 have already established in the inland waters of Slovenia (Povž and Šumer, 2005). The introductions of non-native fish species in Slovenia were performed mainly by fishermen either intentionally (angling and aquaculture), or accidentally while restocking rivers with native species (Povž and Šumer, 2005) and many introductions in Slovenia have been carried out on a repeated basis (Povž and Ocvirk, 1988; Piria *et al.*, 2016a).

Protection of ichthyofauna is provided under the National Freshwater Fisheries Act, Nature Conservation

Act and related decrees, but they are practically ineffective (Povž and Šumer, 2005), and measures to effectively control the introductions or translocations of non-native fish species in Slovenia are still lacking even after the recent EC Regulation 1143/2014 on Invasive Alien Species (EU, 2014) came into force.

To date, there has been only two studies on history of introductions in Slovenia (Povž and Šumer, 2005; Povž, 2017), and since then, several new records of non-native fish species occurred in inland waters of Slovenia (Simonović *et al.*, 2017; Piria *et al.*, 2018). Thus, the aim of this paper was to: (i) update the checklist of known introduced freshwater species in Slovenia, (ii) register and evaluate the vectors and pathways of the recent introductions, and (iii) determine the recent expansion of non-native fish species in Slovenia. Also, potential impact of the newly introduced fish species are discussed.

MATERIALS AND METHODS

Study area

Slovenia's dense river network (river density of 1.33 km⁻²) is extensive (26989 km) and consists of 59 rivers, which are divided hydrologically into the Black Sea and the Adriatic drainages. The majority of the inland waters fall within the Black Sea drainage (16423 km² or 81%); while a smaller part (3850 km² or 19%) belongs to the Adriatic Sea Basin. The Black Sea drainage is dominated by the transboundary Sava River, with its tributaries the Kolpa/Kupa bordering with Croatia and with the transboundary

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of the Drava River (and its tributary Mura) also shared with Croatia. The Soča/Isonzo (139 km) flows through Slovenia draining into the Adriatic at the northeastern Italian coast. However, unlike the large Danube tributaries, most of the rivers of the Adriatic Sea basin form small and isolated catchments, most with a seasonal regime and often drying out during summer. Slovenia has several natural lakes, mostly in alpine region, either of glacial origin, such as the Triglav Lakes (Triglavsko jezera), Lake Bled and Lake Bohinj, the deepest and largest permanent natural lake in Slovenia (3.13 km²), or of karst origin, which are intermittent, such as Cerknica Lake or the numerous smaller polje (karst field) lakes in the Notranjska region.

Data collection and data processing

Historical data were derived from Povž and Šumer (2005) and Povž (2017) and recent data from various published and 'grey' literature sources (*e.g.* books and manuscripts). The degree of acclimatization, suspected impacts on native species and the pathways and vectors of introduction was assessed according to Copp *et al.* (2005), Povž and Šumer (2005) and Piria *et al.* (2018), respectively. The area of recent distribution was estimated as a proportion of the total area of Slovenia, which encompasses 266 squares (Kryštufek *et al.*, 2001), using the UTM Grid zones of the world, converted to classes: (i) <1%, (ii) 1–5%, (iii) 6–20%, (iv) 21–50% and (v) >51% (Table I).

RESULTS AND DISCUSSION

By the end of 2017, a total of 97 fish species had been recorded in Slovenian inland waters, 75 indigenous and 22 introduced (Povž and Ocvirk, 1988; Šumer *et al.*, 2003; Povž and Šumer, 2005; Piria *et al.*, 2016a). At the end of 19th century, five alien fish species (*i.e.* nearly 30% of all registered releases) had been introduced (Table I) which represents the beginning of all future ichthyotransfers. The second wave of introductions occurred between the 1960s and 1970s with four new species recorded (Povž, 1986; Povž and Šumer, 2005). However, the most intensive introductions occurred in the last 45 years (from 1970s until 2015) when 11 new fish species were recorded in Slovenian inland waters (Table I). Furthermore, since the last reported list of alien fish species (Povž and Šumer, 2005; Povž, 2017), two new introduced species has been recorded (No 17-22, Table I).

Most of the introduced species originated from North America (ten species), followed by Asia (seven species), Europe (three species) and two from Africa (Table I) with 18 species now naturalized or acclimatized (Copp *et al.*, 2005) in Slovenian inland waters. Self-sustaining populations in nature 11 of the introduced species have

already established (Table I; Povž and Šumer 2005). European whitefish *Coregonus lavaretus* (Linnaeus, 1758), which drift in from Austria (Kristofič, 1992), are casuals without natural reproduction in Slovenia (Povž and Sket, 1990).

Coho salmon *Oncorhynchus kisutch* (Walbaum, 1792) disappeared within 10 years after introduction (Povž and Sket, 1990) due unknown reasons, and the North African catfish *Clarias gariepinus* (Burchell, 1822) disappeared within a year of introduction from Slovenian inland waters (Povž *et al.*, 2015) due to cold water temperatures during winter (De Graaf *et al.*, 1996). The North African catfish was first reported in two gravel pits of the River Mura basin (Slovenia) in 1997, having been introduced for angling purposes without legal consent. Although not naturalized, North African catfish is still present in Slovenia at fish farms located near Mura River system. This species is widely tolerant of extreme environmental conditions (Froese and Pauly, 2016), but it is unable to survive winter conditions in the Black Sea Basin of Slovenia where water temperatures are < 10°C. Nevertheless, a threat of establishment does still exist due to potential translocations to thermal spring habitats, as demonstrated by the adaptation of Nile tilapia *Oreochromis niloticus*, and to the Adriatic Sea basin in Slovenia (Piria *et al.*, 2016a). This alien fish species could represent a significant risk for the local fish community and other aquatic animals (Muhammad *et al.*, 2017). Nile tilapia was first introduced 2007 to the thermal spring Topla struga near Čatež town, tributary of the Sava River, from where the species is transported downstream by the river currents every summer (Povž *et al.*, 2015), entering the downstream to the Sava River tributaries (D. Zanella, pers. Comm). Black carp *Mylopharyngodon piceus* (Richardson, 1845) was first introduced in 2004 near Slovenska Bistrica at an aquaculture facility and was thereafter occasionally released into surrounding inland waters for sportfishing purposes (Povž, 2009). Similarly, Mississippi paddlefish *Polyodon spathula* (Walbaum, 1792) was for the first time introduced at an aquaculture facility near Rogaška Slatina in 2012 (Povž, 2012). Although there are no confirmed observations of the species in Slovenian inland waters yet, existence of naturalized populations of this species cannot be excluded.

One of the newest records of introduced species are those of bighead goby *Ponticola kessleri* (Günther, 1861) in 2015 (Simonović *et al.*, 2017) in the Sava River near Čatež town. Recently, four of the Ponto-Caspian (P-C) gobies (Pisces, Gobiidae) have been reported in the Danube River Basin in Croatia (bordering country with Slovenia): bighead goby, monkey goby *Neogobius fluviatilis* (Pallas, 1814), round goby *Neogobius melanostomus* (Pallas, 1814), and racer goby *Babka gymnotrachelus* (Kessler, 1857) (Jakovlić *et al.*, 2015).

Table 1.- List of alien fish species recorded in Slovenia, origin, time of introduction, reasons of introduction, mode of expansion, the degree of acclimatization (U, unknown; F, failure; A, acclimatization of adults only; SA, satisfactory; VG, very good), impacts on native species (U, unknown; C, suspected competition with native fish for resources (e.g. habitat and food)), the mode of the current expansion (S, continuous stockings for sportfishing; E, escapes from fish farms and fish ponds; SR, uncontrolled self reproduction; DR, drift; U, unknown) and the area of recent distribution (No. TM grid zones), (i) <1%, (ii) 1–5%, (iii) 6–20%, (iv) 21–50% and (v) >51%. (*established self sustaining populations).

No	Fish species	Origin	Introduction		Mode of expansion after first introduction	Degree of acclimatization	Impacts on native species	Mode of the current expansion	No. TM Grid zones	References
			Time	Reason						
1	Brook trout <i>Salvelinus fontinalis</i> (Mitchill, 1815)*	North America	1892	Sportfishing	Release for sportfishing, self reproduction, escapment from aquaculture	VG	U	S	(iii) (32 squares)	Povž and Šumer, 2005
2	Lake charr <i>Salvelinus umbla</i> (Linnaeus, 1758)*	North America	1928, 1943, 1998	To fill vacant niche, sportfishing	Release for sportfishing, self reproduction, escapment from aquaculture	VG	U	SR	(i) (5 squares)	Povž and Šumer, 2005
3	Rainbow trout <i>Oncorhynchus mykiss</i> (Walbaum, 1792)*	North America	1891	Sportfishing, aquaculture	Release for sportfishing, self reproduction, escapment from aquaculture	VG	C	S, E	(v) (153 squares)	Povž and Šumer, 2005
4	Coho salmon <i>Oncorhynchus kisutch</i> (Walbaum, 1792)	North America	1977	Sportfishing, aquaculture	Disappeared after 10 years of introduction	U	U	U	(i) (1 square - I, 1987)	Povž and Šumer, 2005
5	European whitefish <i>Coregonus lavaretus</i> (Linnaeus, 1758)	Europe	Every year	Indipendent downstream spreading	Drift	F	U	DR	(ii) (6 squares)	Povž and Šumer, 2005
6	Largemouth (black) bass <i>Micropterus salmoides</i> (Lacepède, 1802)*	North America	1892, 1993	Sportfishing	Release for sportfishing, self reproduction	SA	U	SR	(ii) (4 squares)	Povž and Šumer, 2005
7	Pumpkinseed <i>Lepomis gibbosus</i> (Linnaeus, 1758)*	North America	End of 19 th century	Ornamental fish	Self reproduction, escapment from aquaculture	SA	U	SR	(iii) (39 squares)	Povž and Šumer, 2005
8	Brown bullhead <i>Ameiurus nebulosus</i> (LeSueur, 1819)*	North America	1935	Sportfishing, aquaculture	Release for sportfishing, self reproduction, escapment from aquaculture	SA	U	SR	(iii) (18 squares)	Povž and Šumer, 2005
9	Eastern mosquitofish <i>Gambusia holbrooki</i> (Girard, 1859)*	North America	1927	Mosquitos' control	Self reproduction	VG	U	SR	(i) (2 squares)	Povž and Šumer, 2005
10	Silver carp <i>Hypophthalmichthys molitrix</i> (Valenciennes, 1848)	Asia	1963	Aquaculture, sportfishing	Escapment from aquaculture, sportfishing	A	U	S	(iii) (20 squares)	Povž and Šumer, 2005

No	Fish species	Origin	Introduction		Mode of expansion after first introduction	Degree of acclimatization	Impacts on native species	Mode of the current expansion	No. TM Grid zones	References
			Time	Reason						
11	Bighead carp <i>Hypophthalmichthys nobilis</i> (Richardson, 1845)	Asia	1963	Aquaculture, sportfishing	Escapement from aquaculture, sportfishing	A	U	S	(ii) (12 squares)	Povž and Šumer, 2005
12	Grass carp <i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Asia	1963	Aquaculture, sportfishing, weed control	Escapement from aquaculture, sportfishing	A	U	S	(iii) (30 squares)	Povž and Šumer, 2005
13	Topmouth gudgeon <i>Pseudorasbora parva</i> (Temminck and Schlegel, 1846)*	Asia	1986	Accidental introduction	Self reproduction, escapement from aquaculture	VG	U	SR	(ii) (13 squares)	Povž and Šumer, 2005
14	Gibel carp <i>Carassius gibelio</i> (Bloch, 1782)*	Asia	1962	Accidental introduction, sportfishing	Release for sportfishing, self reproduction, escapement from aquaculture	VG	U	SR	(iii) (35 squares)	Povž and Šumer, 2005
15	Goldfish <i>Carassius auratus</i> (Linnaeus, 1758)*	Asia	In 19 th century	Ornamental	From aquaria, self reproduction	VG	U	SR	(iii) (35 squares)	Povž and Šumer, 2005
16	North African catfish <i>Clarias gariepinus</i> (Burchell, 1822)	Africa	1997	Sportfishing	Release for sportfishing (disappeared?)	F	U	U	(i) (1 square)	Povž and Šumer, 2005
17	Black bullhead <i>Ameiurus melas</i> (Rafinesque, 1820)*	North America	Un-known	Sportfishing, aquaculture	Self reproduction	SA	U	SR	(iii) (19 squares)	M. Povž, pers obs
18	Nile tilapia <i>Oreochromis niloticus</i> (Linnaeus, 1758)*	Africa	2007	Aquaculture	Self reproduction in hot springs, escapement from aquaculture	U	U	SR	(i) (1 square)	Povž, 2007
19	Black carp <i>Mylopharyngodon piceus</i> (Richardson, 1845)	Asia	2004; 2012	Accidental introduction or sportfishing	Unknown	U	U	U	(i) (1 square)	Povž, 2009
20	Mississippi paddlefish <i>Polyodon spathula</i> (Walbaum, 1792)	North America	2012	Aquaculture	Not yet present in the rivers and lakes	U	U	U	(i) (1 square)	Povž, 2012
21	Siberian sturgeon <i>Acipenser baerii</i> (Brandt, 1869)	Europe	2015	Accidental introduction	Unknown	U	U	U	(ii) (13 squares)	M. Povž personal observations
22	Bighead goby <i>Ponticola kessleri</i> (Günther, 1861)	Europe	2015	Independent upstream expansion	Independent upstream expansion	U	U	SR	(i) (1 square)	Simonović <i>et al.</i> , 2017

Native distributions of P-C gobies were mostly confined to the lower reaches of the Danube River and to the littoral zone of the Black Sea (Vassilev *et al.*, 2012), while the Djerdap Gorge represented the uppermost range boundary (Miller, 2003). Due their natural dispersal from the native habitat, and their presence near the Slovenian border, bighead goby occurrence was not unexpected in Slovenian inland waters. Monkey goby, round goby and racer goby may occur in near future in the Sava, Mura or Drava Rivers in Slovenia.

The last record of Siberian sturgeon *Acipenser baerii* Brandt, 1869 in 2016 (M. Povž personal observation) represents typical example of insufficient knowledge and lack of expertise. Namely, Siberian sturgeon was released into the Sava and Mura Rivers in Slovenia, due to misidentification of the species with sterlet *Acipenser ruthenus* Linnaeus, 1758, native species for this region.

Still is not known time of introduction of black bullhead *Ameiurus melas* (Rafinesque, 1820) in Slovenia and its recent distribution. Recent research in Croatia has confirmed the dominant presence of black bullhead in both basins (Adriatic and Black Seas), while the brown bullhead *Ameiurus nebulosus* (LeSueur, 1819) is restricted only to the Neretva River and its tributaries (Piria *et al.*, 2018). In Slovenia, most reports refer to brown bullhead (Povž and Šumer, 2005), thus indicating ambiguities and possible misidentifications of these two species.

The major motive for the introduction of non-native fishes to Slovene inland waters was sportfishing (Table I). Other reasons are referred to fill a perceived vacant niche, introduction an exotic angling element to the water body or scapee fish from fish farms and ponds. Escapee from fish farms frequently occurring and probably is responsible for the large number of rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792), and brook trout *Salvelinus fontinalis* (Mitchill, 1815) present downstream of the fish farm outlets (M. Povž personal observation). In most cases, escapee fish have gone unreported.

Research of the impacts to native fish in Slovenian inland waters entirely missing. Competition of several introduced species with native fish species for habitat, food and other resources, due their wide distributions, elevated densities in some locations, or trophic role as obligate or facultative piscivores was only assumed for Slovenia according researches elsewhere (Povž and Šumer, 2005). Furthermore, the new finding of bighead goby in Slovenia was interpreted as a warning of the presence of an yet undefined stressor (Simonović *et al.*, 2017). According to Jurajda *et al.* (2005) the introduction of bighead goby could affect the native fish community by competing with bullhead *Cottus gobio*, stone loach *Barbatula barbatula* and white-finned gudgeon *Romanogobio alpinus*.

Also, their feeding activity can cause a decline in the abundance of native fish species (Piria *et al.*, 2016b). Thus, research on impacts in inland waters of Slovenia are strongly recommended.

Assessment of the proportional area of recent distribution (Table I) revealed that eight species (lake charr *Salvelinus umbla* (Linnaeus, 1758), coho salmon, eastern mosquitofish *Gambusia holbrooki* Girard, 1859, North African catfish, bighead goby, Nile tilapia, paddlefish, black carp) cover <1% of the Slovenian territory. Six species (European whitefish, largemouth bass *Micropterus salmoides* (Lacepède, 1802), bighead carp *Hypophthalmichthys nobilis* (Richardson, 1845), topmouth gudgeon *Pseudorasbora parva* (Temminck and Schlegel, 1846) and goldfish *Carassius auratus* (Linnaeus, 1758) cover 1–5% of the area (*i.e.* four to 13 squares). Six species (brook trout, pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758), brown bullhead and silver *Hypophthalmichthys molitrix* (Valenciennes, 1848), grass *Ctenopharyngodon idella* (Valenciennes, 1844) and gibel *Carassius gibelio* (Bloch, 1782) carps) inhabit 6–20% (*i.e.* 18–39 squares). Still the most abundant and most widely spread is rainbow trout, occupies more than 51% of Slovene territory (153 squares), which was considered as widely distributed species (Kryštufek *et al.*, 2001).

Actions to remediate and/or control introduced fishes are lacking for Slovenia, thus it is necessary to develop better conservation measures and management program and further uncontrolled restocking and dispersal of alien species should be suppressed. Suggestion for future aquatic studies and research are assessing and mitigating impacts of non-native species.

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Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

- Brancelj, A. 1997. Rek, da dokler so ribe v vodi, je vse v redu, žal ne drži vedno in povsod: slovenska visokogorska jezera ogroža (tudi) naseljevanje rib. *Delo*, 39: 10. [in Slovene]
- Brancelj, A., Urbanc-Berčič, O., Krušnik, C., Kosi, G., Povž, M. and Dobravec, J., 1995. Življenje v vodah

- Triglavskega narodnega parka [Freshwater fauna in Triglav National Park]. *Razprave in Raziskave*, 4: 95-96. [in Slovene]
- Copp, G.H., Bianco, P.G., Bogutskaya, N., Eros, T., Falka, I., Ferreira, M.T., Fox, M.G., Freyhof, J., Gozlan, R.E., Grabowska, J., Kovac, V., Moreno-Amich, R., Naseka, A.M., Penaz, M., Povž, M., Przybylski, M., Robillard, M., Russell, I.C., Stakenas, S., Šumer, S., Vila-Gispert, A. and Wiesner, C., 2005. To be, or not to be, a non-native freshwater fish? *J. appl. Ichthyol.*, 21: 242-262. <https://doi.org/10.1111/j.1439-0426.2005.00690.x>
- Čaleta, M., Buj, I., Mrakovčić, M., Mustafić, P., Zanella, D., Marčić, Z., Duplić, A., Mihinjač, T. and Katavić, I., 2015. *Endemic fish of Croatia*. Croatian Environment Agency, Zagreb, pp. 116.
- De Graaf, G. and Janssen, J., 1996. *Handbook on the artificial reproduction and pond rearing of the African catfish Clarias gariepinus in Sub-Saharan Africa Nefisco Foundation, Amsterdam, the Netherlands*. Fisheries Technical Paper 362, FAO, Rome, pp. 109.
- Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.H., Soto, D., Stiassny, M.L.J. and Sullivan, C.A., 2006. Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biol. Rev.*, 81: 163-182. <https://doi.org/10.1017/S1464793105006950>
- EU, 2014. Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. *Offic. J. Europ. Union*, 57: 35-55.
- Froese, R. and Pauly, D. (eds.), 2016. *FishBase*. World Wide Web Electronic Publication. www.fishbase.org (version 10/2016).
- Jakovlić, I., Piria, M., Šprem, N., Tomljanović, T., Matulić, D. and Treer, T., 2015. Distribution, abundance and condition of invasive Ponto-Caspian gobies *Ponticola kessleri* (Gunther, 1861), *Neogobius fluviatilis* (Pallas, 1814), and *Neogobius melanostomus* (Pallas, 1814) in the River Sava basin, Croatia. *J. appl. Ichthyol.*, 31: 888-894. <https://doi.org/10.1111/jai.12803>
- Jurajda, P., Černý, J., Poláčik, M., Valová, Z., Janáč, M., Blažek, R. and Ondračková, M., 2005. The recent distribution and abundance of non-native *Neogobius* fishes in the Slovak section of the River Danube. *J. appl. Ichthyol.*, 21: 319-323. <https://doi.org/10.1111/j.1439-0426.2005.00688.x>
- Kristofič, T., 1992. Zanimiv ulov nove vrste ribe v Sloveniji [New fish species in Slovenia]. *Ribic*, 51: 8. [in Slovene]
- Kryštufek, B., Bedjanič, M., Brelih, S., Budihna, N., Gomboc, S., Grobelnik, V., Kotarac, M., Lesnik, A., Lipej, L., Marti, A., Poboljšaj, K., Povž, M., Rebeušek, F., Salamun, S., Tome, S., Trontelj, P. and Wraber, T., 2001. *Raziskava razširjenosti evropsko pomembnih vrst v Sloveniji [Distribution of European important freshwater fishes in Slovenia]*. Prirodoslovni muzej Slovenije [Report], pp. 364. [in Slovene]
- Miller, P.J., 2003. Mugilidae, Atherinidae, Atherinopsidae, Blennidae, Odontobutidae, Gobiidae. In: *The freshwater fishes of Europe*, Vol. 8/1. AULA-Verlag GmbH, Wiebelsheim, pp. 404.
- Mrakovčić, M., Brigić, A., Buj, I., Čaleta, M., Mustafić, P. and Zanella, D., 2006. *Crvena knjiga slatkovodnih riba Hrvatske (Red book of freshwater fish of Croatia)*. Ministry of Culture, State Institute for Nature Protection, Republic of Croatia, Zagreb, pp. 253. [in Croatian with English Introduction]
- Muhammad, H., Iqbal, Z. and Saleemi, S., 2017. Diversity and distribution of fish fauna of Indus River at Taunsa Barrage in Punjab, Pakistan. *Pakistan J. Zool.*, 49: 155-161. <http://dx.doi.org/10.17582/journal.pjz/2017.49.1.155.161>
- Munda, A., 1924. Ameriški ostriž (*Grystes salmoides* Gunth.) (Large mouth bass). *Lovec*, 9: 93. [in Slovene]
- Nico, L. and Fuller, P., 2005. *Hypophthalmichthys nobilis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Available from <http://nas.er.usgs.gov/queries/FactSheet.asp>
- Piria, M., Povž, M., Vilizzi, L., Zanella, D., Simonović, P. and Copp, G., 2016a. Risk screening of non-native freshwater fishes in Croatia and Slovenia using the fish invasiveness screening kit. *Fish. Manage. Ecol.*, 23: 21-31. <https://doi.org/10.1111/fme.12147>
- Piria, M., Jakšić, G., Jakovlić, I. and Treer, T., 2016b. Dietary habits of invasive Ponto-Caspian gobies in the Croatian part of the Danube River basin and their potential impact on benthic fish communities. *Sci. Total Environ.*, 540: 386-395. <https://doi.org/10.1016/j.scitotenv.2015.05.125>
- Piria, M., Simonović, P., Nikolić, V., Ristovska, M., Apostolou, A., Adrović, A., Povž, M., Zanella, D., Mrdak, D., Milošević, D., Vardakas, L., Koutsikos, N., Kalogianni, E., Gregori, A., Kostov, V., Škrijelj, R., Korro, K., Bakiu, R., Tarkan, A.S. and Joy, M.K., 2018. Alien freshwater fish species in the Balkans – vectors and pathways of introduction. *Fish*

- Fisheries*, 19: 138–169. <https://doi.org/10.1111/faf.12242>
- Povž, M., 1986. Naseljevanje in preseljevanje sladkovodnih rib v Sloveniji. [Introductions and transplantations of freshwater fishes in Slovenia] Ljubljana. *Ribič*, 45: 252-254. [in Slovene].
- Povž, M. and Ocvirk, A., 1988. Freshwater fish introductions and transplantations in Slovenia. *Ichthyos*, 8: 1-10.
- Povž, M. and Sket, B., 1990. *Naše sladkovodne ribe [Freshwater fishes]*. Mladinska Knjiga, Ljubljana, pp. 367.
- Povž, M., 2009. Black carp *Mylopharyngodon piceus* (Richardson, 1845). *Ribič*, 7-8: 197-198. [in Slovene]
- Povž, M., 2012. American paddlefish, *Polyodon spathula* (Walbaum, 1792). *Ribič*, 1-2: 16-17. [in Slovene]
- Povž, M. and Šumer, S., 2005. A brief review of non-native freshwater fishes in Slovenia. *J. appl. Ichthyol.*, 21: 316-318. <https://doi.org/10.1111/j.1439-0426.2005.00687.x>
- Povž, M., Gregori, A. and Gregori, M., 2015. *Freshwater fish and lampreys in Slovenia*. Zavod Umbra, Ljubljana, pp. 293. [in Slovene]
- Povž, M., 2017. Non-native Freshwater Fishes in Slovenia. *Acta Zool. Bulg.*, 9: 105-110.
- Simončič, A., 1948. Jezerska zlatovčica v Bohinjskem jezeru [Arctic charr in the lake Bohinjsko jezero]. *Ribič*, 7: 609 [in Slovene]
- Simonović, P., Piria, M., Zuliani, T., Ilić, M., Marinković, N., Kračun-Kolarević, M. and Paunović, M., 2017. Characterization of sections of the Sava River based on fish community structure. *Sci. Total Environ.*, 574: 264-271. <https://doi.org/10.1016/j.scitotenv.2016.09.072>
- Šumer, S., Povž, M. and Seliškar, T., 2003. *Analiza bioloških obremenitev in vplivov na vode – pregled in posledice vnosov in preseljevanj sladkovodnih ribjih vrst in po Sloveniji in vpliv na oceno ekološkega stanja vodnih teles v okviru direktive o vodah [Biological impacts on inland waters in Slovenia: non-native freshwater fishes in Slovenia]*. Report. EBRA d.o.o. Ljubljana, pp. 56. [in Slovene]
- Vassilev, M., Apostolou, A., Velkov, B., Dobrev, D. and Zarev, V., 2012. *Atlas of the gobies (Gobiidae) in Bulgaria*. Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Science, Sofia, Bulgaria, pp. 112.