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Current Knowledge on the Status of the Most Common Non-indigenous Fish Species in the Transboundary Greater Prespa Lake (Albanian Side)

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Abstract: In this paper, the current state of non-indigenous fish species in the Greater Prespa Lake (Albanian side) is clarified. As in other big lakes on the Balkans, e.g. the Ohrid and Scadar Lakes, the Greater Prespa Lake is facing changes concerning fish biodiversity, including an increased presence of non-indigenous species. Following that, the native fish populations (well-known globally for their endemic and relict species) are seriously threatened by anthropogenic impacts. Although the Prespa Lakes region has been recognised as an European and global biodiversity hot spot because of the number of species and habitats, alien fish species are common inhabitants. The most abundant non-indigenous species are *Pseudorasbora parva* and *Rhodeus amarus*. *Carassius gibelio, Lepomis gibbosus, Cyprinus carpio* and *Tinca tinca* are represented with lower relative abundance. Six other aliens (recorded by previous studies), are not registered by the present study. The average relative non-indigenous species abundance was lower and their average relative biomass per m^2 higher than the respective parameters of the indigenous species. Clear connection between their abundance and biomass could not be derived from the available data.

Keywords: fish populations, abundance, biomass, monitoring, endemic

Introduction

Fish are a prominent feature in most national economies but the risk management measures are generally less stringent for fish (Copp et al. 2005) than for terrestrial plants, plant pests and animals (especially mammals). Based on various information there is an increased concern over the potential impacts of introduced on native species, ecosystems, local and national economies and societies, through direct (Manchester & Bullock 2000) or indirect effects, e.g. parasites or pathogens (Kennedy 1975). Further, naturalisation of marine and freshwater invaders may be irreversible or unpredictable (ICES 2005) and it is arguable whether any intentional introductions are acceptable (Smith et al. 1999).

Human facilitation of the movement of living organisms across continents has caused profound alteration in the ecology of relocated species and the communities to which they have been introduced (Callaway et al. 2006). The rate of increase and the scale of these movements is rapidly becoming a major focus of ecologists, conservation biologists and resource managers around the world (Williamson 1996) partially due to the introduction of exotic species, which are causing or may cause various threats to native biodiversity (Fernando 1991, Dudgeon 2006). Globalisation and growth in the volume of trade and tourism, coupled with the emphasis on free trade, provide more opportunities for fish species to be spread both deliberately and accidentally (Welcomme 1984, Cohen & Carlton 1998, Sampson et al. 2009). Such factors might affect seriously native fish population and diversity. Worldwide experience has shown that a number of problems follow the introduction of a new species. e.g.: disruption of the receiving environment; predation and inter-specific competition; overcrowding and stunting; genetic degradation; introduction of parasites and disease and extinction of many native species (Zaret & Paine 1973, Taylor et al. 1984, Welcomme 1988, 2001, Johnson et al. 2006).

During the last decades, non-indigenous species are increasing their presence in the Balkan Region, which is characterised by a high level of endemism (Simonović et al. 2013). Non-indigenous species are mentioned in the Directive's annexes as an important environmental pressure and as such require appropriate assessment and management (WFD 2000).

Despite the attempts done so far, the knowledge about the diversity and distribution patterns of freshwater fishes and particularly conservation status of some areas on the Balkan Peninsula remains poor. Data on Albanian species are missing, apart from those on loaches (Šanda et al. 2008), salmonids (Snoj et al. 2009) and barbels (Marková et al. 2010). The main sources of information are the works of Poljakov et al. (1958), which include 36 freshwater species, and Rakaj (1995) with data on 77 species. There is a significant gap in the knowledge on the diversity of freshwater fishes of Albania, which has been confirmed by recent descriptions of many new species from the area (Bianco & Kottelat 2005, Economidis 2005, Kovačić & Šanda 2007, Miller et al. 2008, Zupančič et al. 2010, Bogutskaya et al. 2010). Distribution and taxonomic status data are essential for successful conservation efforts and for undertaking effective conservation measures.

The recent water quality assessment attempts confirm that the degree of nutrient enrichment of the Greater Prespa Lake is very high not only in the littoral but also in the pelagic zone. Insufficient sewer systems and waste water treatment, together with intensive agriculture, particularly on the Macedonian side of the border (including vast apple growing areas), lead to eutrophication of the lake (G.I.Z. 2010). The abundance of non-native fish species could be connected with eutrophication, habitat degradation, as well as weak fisheries' management (Shumka et al. 2008, 2015, Spirkovski et al. 2012). Talevski et al. (2009) reported for the Prespa Lake 12 native fish, including *Cyprinus carpio* L., 1758 and 11 introduced fish species. Later, *Cyprinus carpio* was assumed as alien for the system (Spirkovski et al. 2012). Nine of the ten native species are also endemic: *Alburnoides prespensis*, *Alburnuss belvica*, *Barbus prespensis*, *Chondrostoma prespense*, *Cobitis meridionalis*, *Pelasgus prespensis* and *Rutilus prespensis*, all described by Karaman (1924), as well as *Salmo peristericus* Karaman, 1938 and *Squalius prespensis* Fowler, 1977, whereas *Anguilla anguilla* L., 1758 represents a Pan-European inhabitant. *Chondrostoma prespense* and *S. peristericus* are included in the IUCN Red List of Threatened Species (2016) as VU and EN, respectively.

Recently, the scientific interest about alien fish species' dispersion and their negative impact on the natural ecosystems and human activities is increasing altogether with their distribution. A plethora of surveys have been performed about their new habitats and modes of introduction (e.g. Yankova 2016, Zorić et al. 2014, Zenetos et al. 2009) or their biology (Uzunova et al. 2008, Simonović et al. 2001), but no such attention is paid to the interrelationships native-alien fish. In connection with the increasing anthropogenic pressure in all ecosystems, the aim of the study is to contribute preliminary data about the basic population parameters of the non-indigenous species in the Greater Prespa Lake.

Materials and Methods

The Prespa Lakes Basin is a high altitude system (850-2600 m a.s.l.) with a catchment area of over 2,500 km^2. It covers parts of the territories of Albania, Macedonia and Greece. The Greater (Macro) Prespa Lake has a surface area of 285 km^2 with a maximum water depth of 54 m. The Micro Prespa Lake has a smaller surface area of 47 km^2 and is shallower, with a maximum water depth of 9 m.

Fish multi-habitat sampling was performed from 2013 to 2015 according to the CEN 14757 standardised protocol, using 30 m long and 1.5 m deep benthic multi-mesh gill nets, composed of 12 panels with different mesh sizes ranging from 5 mm to 55 mm from knot to knot in the following order: 43mm, 19.5 mm, 6.25 mm, 10 mm, 55 mm, 8 mm, 12.5 mm, 24 mm, 15.5 mm, 5 mm, 35 mm and 29 mm. Based on the lake's characteristics, bathymetry, habitat differentiation, and earlier long term practise in experimental fishing, the Albanian part of the lake was divided in two sub basins (Fig. 1). Nets were set before dusk, stayed overnight and after down were taken out (12 hours of sampling) to cover the both highest activity circadian peaks. Nets were processed panel per panel, species and individual measuring was performed afterwards. Following the depth strata (from bathymetric map 0-3m, 3-6 m and 6-12 m) and guidance (CEN 2004, 2005a, 2005b), the number of nets in total were set at 32 per sub basin 1 and 32 for sub basin 2.

CPUE values (Catch per unit of effort) was calculated for each net and each netted species as a measure of species abundance. CPUE was calculated as follows: total catch of each species in grams in multi-mesh net (all panels) divided by the net surface (1,5m X 30m = 45m^2, CPUE grams) and total number for each species in multi-mesh net (all panels) divided by the net surface (1,5m X 30m = 45m^2, CPUE individuals). Since all nets were fishing approximately 12 hours we have not included this in the CPUE calculation, so the CPUE values are in gr/m^2 and in No of ind./m^2, but not in gr/m^2/hours of fishing nor in Number of ind./m^2/hours of fishing. The average CPUE value for each species in each stratum (0-3m, 3-6m and 6-12 m strata) was calculated as a sum of each net CPUE value of species *N*/number of nets per stratum. Basic population parameters (abundance in ind/m2 and biomass in g/m2) were calculated from the raw data. A PCA plot was constructed, in order to establish the most distinguishing population parameter among the three years of sampling with PAST (Hammer et al. 2001).

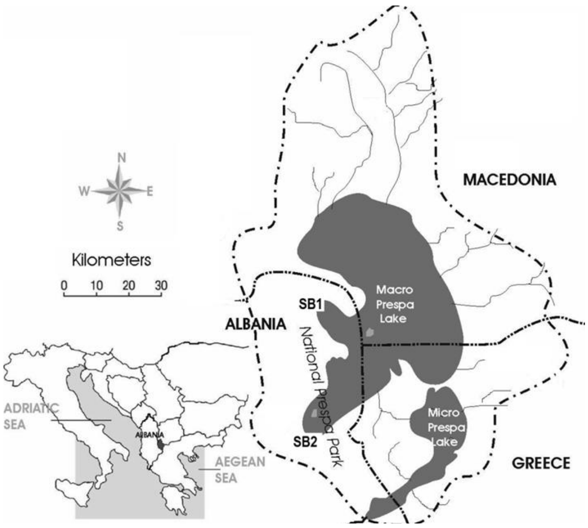

Fig. 1. Map of Prespa Lakes. Note Sub-basin 1 (SB1) and Sub-basin 2 (SB2) in the Greater Prespa Lake.

Results

During the three years of sampling, 15 fish species were recorded from the Albanian part of the Greater Prespa Lake. The most abundant non-indigenous species were the following: *Pseudorasbora parva* and *Rhodeus amarus,* while *Carassius gibelio*, *Lepomis gibbosus, Cyprinus carpio* and *Tinca tinca* were represented by lower relative abundance (Table 1). We did not register other alien fish mentioned before: *Ctenopharyngodon idella* Valenciennes, 1844, *Hypophthalmichthys molitrix* Valenciennes, 1844, *Oncorhynchus mykiss* Walbaum, 1792, *Salmo letnica* Karaman, 1924. These four species most probably do not support viable populations in the lake, due to their requirements for reproduction. The recent population density of *Parabramis pekinensis*

Table 1. Fish species in the Greater Prespa Lake according to different surveys and current data collected from 2013 to 2015.

Fish species in the Greater Prespa Lake		Crivelli et al. (1997)	Talevski et al. (2009)	Present study % abundance	Origin
Native	*Alburnoides prespensis*	+	+	**19.91**	native
	Alburnus belvica	+	+	**9.49**	native
	Anguilla anguilla	+	+	**-**	native
	Barbus prespensis	+	+	**0.41**	native
	Chondrostoma prespense	+	+	**0.29**	native
	Cobitis meridionalis	+	+	**0.2**	native
	Pelasgus prespensis	+	+	**1.7**	native
	Rutilus prespensis	+	+	**4.56**	native
	Salmo peristericus	+	+	**0.005**	native
	Squalius prespensis	+	+	**0.13**	native
Alien	*Carassius gibelio*	+	+	**0.13**	Yes
	Ctenopharyngodon idella	+	+	**-**	No
	Cyprinis carpio	+	+	**1.4**	Yes
	Gambusia holdbrooki	-	+	**-**	Yes
	Hypophthalmichthys molitrix	+	+	**-**	No
	Lepomis gibbosus	+	+	**1.62**	Yes
	Oncorhynchus mykiss	+	+	**-**	No
	Parabramis pekinensis	+	+	**-**	Unknown
	Pseudorasbora parva	+	+	**21.46**	Yes
	Rhodeus amarus	+	+	**38.47**	Yes
	Salmo letnica	+	+	**-**	No
	Silurus glanis	+	+	**-**	Unknown
	Tinca tinca	+	+	**0.23**	Yes

Basilewsky, 1855 and *Silurus glanis* L., 1758 remains unclarified, since it has not been established. *Gambusia holdbrooki* Girard, 1859 was not captured, in accordance with Crivelli et al. (1997). Talevski et al. (2009) consider the species as present for the Prespa system, without further clarification concerning its existence in the Greater or the Micro Prespa Lakes. There is also evidence for an unsuccessful introduction of *Esox lucius* L., 1758 in the lake (Crivelli et al. 1997) and this species is not included in Table 1.

The native *Anguilla anguilla* was not established either. As a whole, the relative average abundance (ind/m^2) of indigenous fish species was lower than that of the non-indigenous, contrariwise to their biomass (g/m^2; Fig. 2). The explanation of this is in the higher established density of small-bodied aliens, mostly *Pseudorasbora parva* and *Rhodeus amarus*.

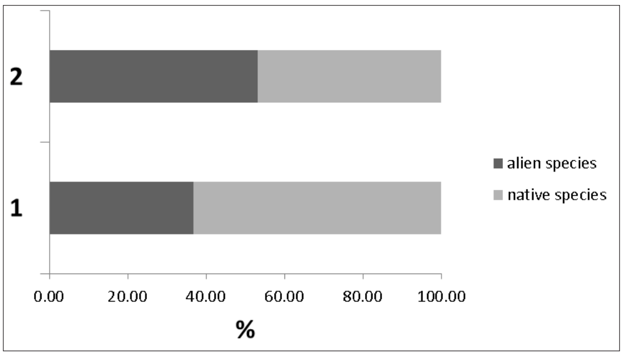

Fig. 2. Relative average abundance in ind (2) and biomass in g (1) per m^2 of indigenous and non-indigenous fish species in the Greater Prespa Lake (Albanian part) during the period 2013-2015.

Discussion

There are no direct indications for the impact of non-indigenous species on native ones as in other cases, e.g. in the Czech Republic (Lusk et al. 2010), and further studies are needed to cover different aspects of fish biology. A superficial inverse relationship of biomass and abundance of the indigenous species compared to non-indigenous can be seen (Fig. 3), but this hypothesis should be supported by longer time-series data. Inverse relationship between the alien and native species' abundance and biomass according to sampling depth has been also established (Fig. 4). This tendency mainly depended on the massive numbers of *Pseudorasbora parva* and *Rhodeus amarus*, both of which supported high population densities mainly near the shore, but not in the deeper horizons.

Nevertheless, what is growing as concern is, that the non-indigenous species slowly are increasing their biomass independently of their abundance, as shown in the performed PCA analysis (Fig. 5). The most distinguishing parameter between the three years of sampling according to the same analysis was the total average abundance of non-indigenous species on the basis of the assumption, that the 1st principal component explains 94 % of the variation.

Recently, the presence of non-indigenous species in the Balkan region has been increasing not only in natural lakes (e.g. Barbieri et al. 2015, Knežević & Marić 1979, Kostov 2008, Leonardos et al. 2008) but also in reservoirs (Uzunova & Zlatanova 2007),

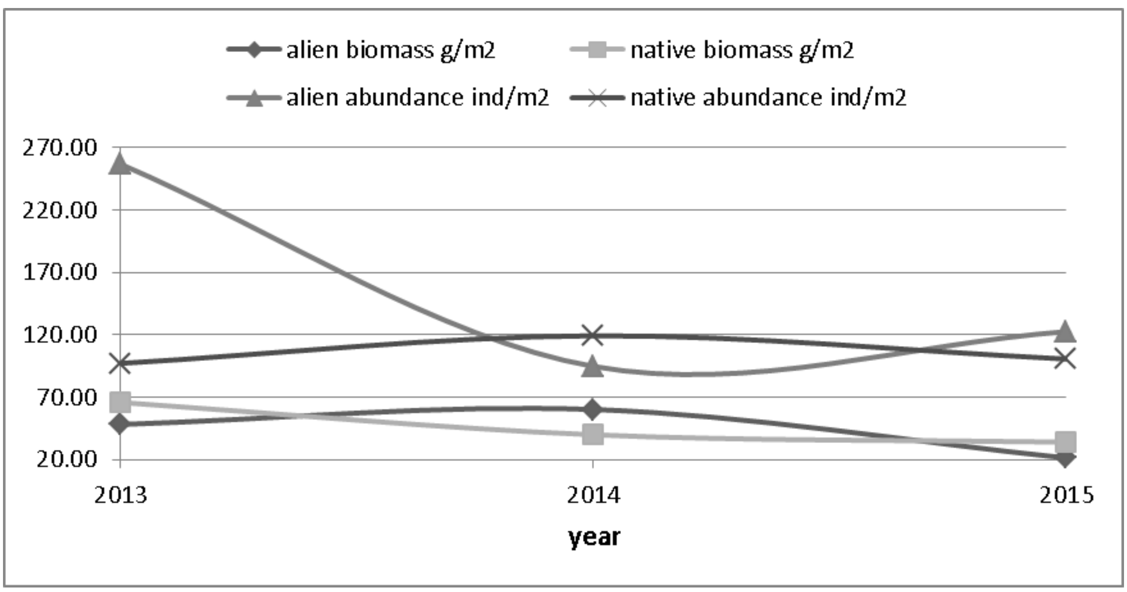

Fig. 3. Changes of biomass (g) and abundance (ind) per m^2 of indigenous and non-indigenous fish species in the Greater Prespa Lake (Albanian part) from 2013 to 2015.

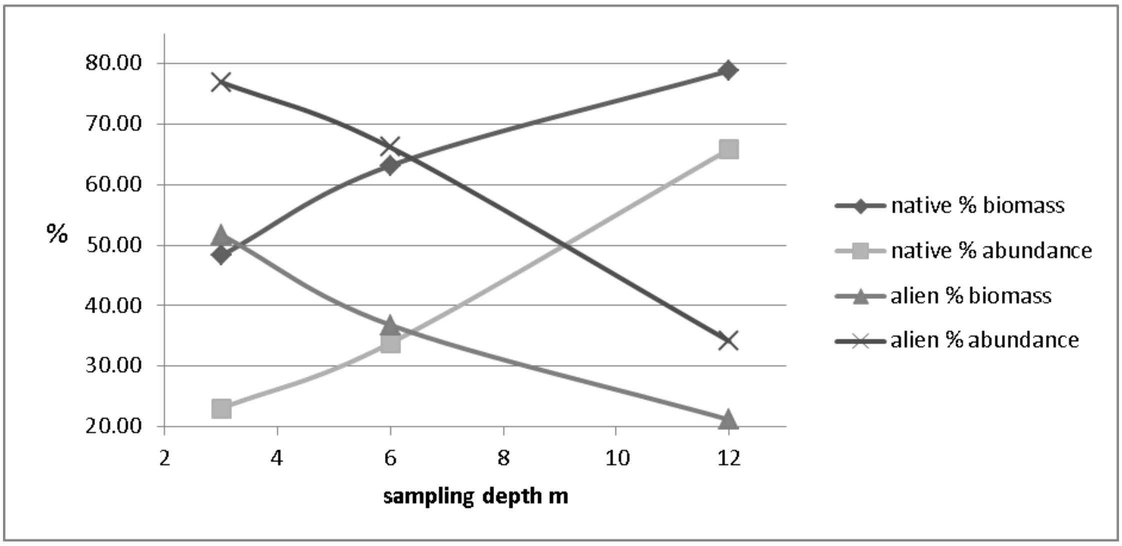

Fig. 4. Changes of averaged % biomass and % abundance of indigenous and non-indigenous fish species in the Greater Prespa Lake (Albanian part) during the period 2013-2015 according to sampling depth.

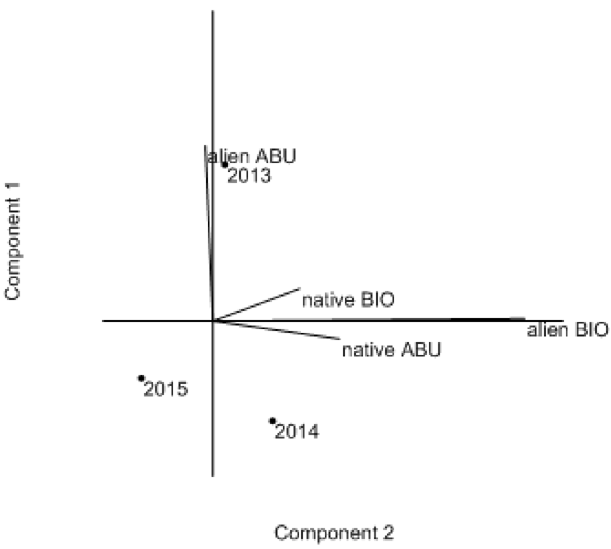

Fig. 5. PCA scatter plot of biomass (g) and abundance (ind.) per m^2 of indigenous and non-indigenous fish species in the Greater Prespa Lake (Albanian part) from 2013 to 2015. ABU=abundance in ind/m^2, BIO = biomass in g/m^2.

which are widely accepted as unstable and vulnerable systems. Studies of lake fish diversity suggest that there is presumably no individual factor that simultaneously predicts diversity, size and density of fish across large spatial gradients. Natural factors and anthropogenic pressures may strongly interact in determining the local fish assemblage. While facing the freshwater biodiversity crisis (Dudgeon et al. 2006, Vörösmarty et al. 2010), it is important to estimate their relative contribution for the macro ecological patterns of fish diversity in lakes, especially where high endemism occurs, as is the case in the Greater Prespa lake (all native and 60% of the total number of registered species). However, to accomplish this, as well as to distinguish the impact of alien species on the native fish community (Crivelli 1995), multiannual data obtained by systematic sampling including fish species, density and size, are needed.

Recently, agricultural activities have resulted in higher diffuse source nutrient loading to the Prespa Lake. About 920 tons of nitrogen and 477 tons of phosphorus are released each year only in the Macedonian watershed of the Prespa Lake (UNDP 2012). In total, it is estimated that around 64 tons of pesticides are used each year. Significant quantities of mainly organic waste (waste apples and yard waste) and hazardous solid waste, generated by agricultural activities (pesticide packaging), are disposed of in the river channel and the riparian corridor. This has a significant negative impact on surface water bodies, ground waters and soil, especially in the Golema Reka water ecosystem (UNDP 2012). Besides agricultural activities, littoral activities like land cultivation and human settlements in the watershed (in three littoral states) also contribute to the overall load of diffuse source-derived pollution. Most villages are not connected to the sewage treatment plants and represent significant diffuse source of pollution. Some of these have high tourist capacities and represent relatively important diffuse sources of pollution.

Native fish populations and particularly intolerant endemic species, such as *Salmo peristericus*, inhabiting the Greater Prespa Lake ecosystem are more vulnerable to separate and cumulative anthropogenic activities and factors (e.g. water pollution and lack of integrated management approaches, unregulated fishery practices, illegal fishing, overfishing, impacts on specific spawning grounds, poor integration of fishery management practices into the entire management of the Prespa National Park), alongside with the invasion of non-indigenous fish. Their impact on the specific ichthyocoenose can be direct or indirect (Lusk et al. 2010) and probably temporarily reflects on their main population characteristics. On the basis of the assumption that one of the most insidious threats to fish conservation is the introduction of new species (Lowe-McConnel 1990), constant complex monitoring and pressures specification has to be performed for management purposes according to the national legislation and WFD, especially in protected areas as the Greater Prespa Lake.

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References

Barbieri R., Zogaris S., Kalogianni E., Stoumboudi M. T., Chatzinikolaou Y., Giakoumi S., Kapakos Y., Kommatas D., Koutsikos N., Tachos V., Vardakas L. & Economou A. N. 2015. Freshwater Fishes and Lampreys of Greece: An annotated checklist. Monographs on Marine Sciences No. 8. Hellenic Centre for Marine Research: Athens, Greece, 130 p.

Bianco P. G. & Kottelat M. 2005. *Scardinius knezevici*, a new species of rudd from Lake Skadar, Montenegro (Teleostei: Cyprinidae). Ichthyological Exploration of Freshwaters 16 (3): 231–238.

Bogutskaya N. G., Zupančič P. & Naseka A. M. 2010. Two new species of freshwater fishes of the genus *Alburnoides, A. fangfangae* and *A. devolli* (Actinopterygii: Cyprinidae), from the Adriatic Sea basin in Albania. Proceedings of the Zoological Institute, Russian Academy of Sciences 314 (4): 448–468.

Callaway R. M. & Maron J. L. 2006. What have exotic plant invasions taught us over the past 20 years? Trends in Ecology and Evolution 21: 369-374.

CEN 2004. Water quality — guidance standard on the design of multimetric indices. Document CEN/TC 230 N 0504. Brussels. CEN.

CEN 2005a. Water quality — guidance on the scope and selection of fish sampling methods. Brussels. CEN.

CEN 2005b. Water quality — sampling of fish with multi-mesh gill nets. Brussels. CEN.

Cohen A. N. & Carlton J. 1998. Accelerating invasion rate in a highly invaded estuary. Science 279: 555-558.

Copp G. H., Garthwaite R. & Gozlan R. 2005. Risk identification and assessment of non-native freshwater fishes: a summary of concepts and perspectives on protocols for the UK. Journal of Applied Ichthyology 21: 371–373.

Crivelli A. J. 1995. Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region? Biological Conservation 72: 311-319.

Crivelli A., Catsadorakis G., Malakou M. & Rosecchi E. 1997. Fish and fisheries of the Prespa lakes. Hydrobiologia **351**: 107–125.

Dudgeon D., Arthington A. H., Gessner M. O., Kawabata Z., Knowler D. & Leveque C. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Reviews 81: 163–182.

Economidis P. S. 2005: *Barbatula pindus*, a new species of stone loach from Greece (Teleostei: Balitoridae). Ichthyological Exploration of Freshwaters, 16 (1): 67–74.

Fernando C.H. 1991. Impacts of fish introductions in tropical Asia and America. Canadian Journal of Fisheries and Aquatic Sciences 48: 24-32.

G.I.Z. 2010. Initial characterization of Lakes Prespa, Ohrid and Shkodra/Scadar. Implementing the EU Water Framework Directive in Soutrh Eastern Europe. Tirana 132 p. www.moepp.gov.mk/wp-content/uploads/2015/01/ICR-3-Lakes-Main-Report.pdf

Hammer Ø., Harper D. A. T. & Ryan P. D. 2001. PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica, 4 (1): 9 p. palaeo-electronica.org/2001_1/past/issue1_01.htm

ICES 2005. Code of Practice on the Introductions and Transfers of Marine Organisms 2005. International Council for the exploration of the Sea, Copenhagen 32 p. https://www.nobanis.org/globalassets/ices-code-of-practice.pdf

IUCN 2016. . The IUCN Red List of Threatened Species. Version 2016-3. http://www.iucnredlist.org/

Johnson L.E., Bossenbroek J. & Kraft C. 2006. Patterns and pathways in the post-establishment spread of non-indigenous aquatic species: the slowing invasion of North American inland lakes by the zebra mussel. Biological Invasions, 8: 475-489.

Kennedy C. R. 1975. The distribution of crustacean fish parasites in Britain in relation to the introduction and movement of freshwater fish. *J. Inst. Fish. Mgmt*, **6**: 36–41.

Kovačić M. & Šanda R. 2007. A new species of *Knipowitschia* (Perciformes: Gobiidae) from southern Montenegro. Journal of the National Museum (Prague), Natural History Series 176 (5): 81–89.

Kostov V. 2008. Results of ichthyofauna investigation in Macedonian part of Lake Dojran. p. 189–201. In: 1st Symposium for Protection of Natural Lakes in Republic of Macedonia, Ohrid, 31 May – 3 June 2007. Ministry of Education and Sciences of Republic of Macedonia, Ohrid.

Knežević B. & Marić D. 1979. *Perca fluviatilis* Linnaeus, 1758 (Percidae, Pisces), new species for the Jugoslavian part of Scadar Lake. Glasnik Republičkog zavoda za zaštitu prirode – Priodnjačkog muzeja, 12: 177-180. (In Serbian).

Leonardos I., Tsikliras A., Eleftheriou V., Cladas Y., Kagalou I., Chortatou R. & Papigioti O. 2008. Life history characteristics of an invasive cyprinid fish (*Carassius gibelio*) in Chimaditis Lake (northern Greece). Journal of Applied Ichthyology 24: 213-217.

Lowe-Mcconnell R. 1990. Summary address: rare fish, problems, progress and prospects for conservation. In: Wheeler A. et al. The biology and conservation of rare fish: the Fisheries Society of the British Isles symposium held at Lancaster University, UK, 16-20 July 1990. Journal of Fish Biology 37 (Suppl. A): 263-269.

Lusk S., Lusková V. & Hanel L. 2010. Alien fish species in the Czech Republic and their impact on the native fish fauna. Folia Zoologica 59 (1): 57 – 72.

manchester S. J. & Bullock J. 2000. The impacts of non-native species on UK biodiversity and the effectiveness of control. Journal of Applied Ecology 37: 845–864.

Marková S., Šanda R., Crivelli A., Shumka S., Wilson I. F., Vukić J., Berrebi P. & Kotlík P. 2010. Nuclear and mitochondrial DNA sequence data reveal the evolutionary history of *Barbus* (Cyprinidae) in the ancient lake systems of the Balkans. Molecular Phylogenetics and Evolution **55**: 488–500.

Miller P. J. & Šanda R. 2008. A new West Balkanian sand-goby (Teleostei: Gobiidae). Journal of Fish Biology 72: 259–270 doi:10.1111/j.1095-8649.2007.01709.x.

Poljakov G. D., Filipi N., Basho K. & Hysenaj A. 1958: Pesquit e Shqiperise [Fishes of Albania]. Mihal Duri, Tirana, 286 p. (in Albanian).

Rakaj N. 1995. Iktiofauna e Shqiperise [Ichthyofauna of Albania]. Shtëpia Botuese "Libri Universitar", Tirana, 700 p. (in Albanian).

Sampson S. J., Chick J. & Pegg M. 2009. Diet overlap among two Asian carp and three native fishes in backwater lakes on the Illinois and Mississippi rivers. Biological Invasions 11: 483-496.

Šanda R., Vukić J., Choleva L., Křížek J., Šedivá A., Shumka S. & Wilson I. F. 2008. Distribution of loach fishes (Cobitidae, Nemacheilidae) in Albania, with genetic analysis of populations of *Cobitis ohridana*. Folia Zoologica 57 (1–2): 42–50.

Shumka S., Paparisto A. & Grazhdani S. 2008. Identification of non-native freshwater fishes in Albania and assessment of their potential threats to the national biological freshwater diversity. BALWOIS Conference, 21-31 May 2008, Ohrid, Republic of Macedonia, 6 p. balwois.com/proceedings/?k9_balwois_conference=50&k9_balwois_topics=All&k9_balwois_country=All&k9_balwois_author=2081

Shumka S., Aleksi P., Mali S. & Trajçe K. 2015. Implementing standard EU method for sampling freshwater fish with multi-mesh gillnets in lakes sub basins (Prespa Lake, Albania). SYLWAN 159 (2): 326-329.

Simonović P., Tošić A., Vassilev M., Apostolou A., Mrdak D., Ristovska M., Kostov V., Nikolić V., Škraba D., Vilizzi L. & Copp G. H. 2013. Risk assessment of non-native fishes in the Balkans Region using FISK, the invasiveness screening tool for non-native freshwater fishes. Mediterranean Marine Science, 14 (2):369-376.

Simonović P., Paunović M. & Popović S. 2001. Morphology, feeding and reproduction of the round goby, *Neogobius melanostomus* (Pallas) in the Danube River basin, Yugoslavia. Journal of Great Lakes Research 27: 281-289.

Smith C. S., Lonsdale W. & Fortune J. 1999. When to ignore advice: invasion predictions and decision theory. Biological Invasions 1: 89–96.

Snoj A., Marić S., Berrebi P., Crivelli A. J., Shumka S. & Sušnik S. 2009. Genetic architecture of trout from Albania as revealed by mtDNA control region variation. Genetics Selection Evolution, 41 (22): 1–11.

Spirkovski Z., Ilik-Boeva D., Talevski T., Palluqi A. & Kapedani E. 2012. The Fish of Prespa. National and University Library St. Kliment Ohridski, Skopje UNDP Scopie, 146 p. http://www.mk.undp.org/content/dam/the_former_yugoslav_republic_of_macedonia/docs/Fish%20of%20Prespa.pdf

Talevski T., Milosevic D., Maric D., Petrovic D., Talevska M. & Talevska A. 2009. Biodiversity of ichtyophanuna from Lake Prespa, Lake Ohrid and Lake Scadar. Biotechnology & Biotechnological Equipment 23: 400-404.

Taylor J. N., Courtenay W. R. & McCann J. A. 1984. Known Impacts of Exotic Fishes in the Continental United States. In: Courtenay W. R. & Stauffer J. R. (Eds): Distribution, Biology, and Management of Exotic Fishes. Baltimore: Johns Hopkins University Press, 423 p.

UNDP 2012. Prespa Lake watershed management plan. United Nations Development Program, Skopje, Macedonia, 134 p. http://balwois.com/wp-content/uploads/2015/02/2012-Prespa-Watershed-Management-Plan-RDM.pdf

Uzunova E. & Zlatanova S. 2007. A review of fish introductions in Bulgarian freshwaters. Acta Ichthyologica et Piscatoria 37: 55-61.

Uzunova E., Velkov B., Studenkov S., Georgieva M., Nikolova M., Pehlivanov L. & Parvanov D. 2008. Growth, age and size structure of the introduced pumpkinseed (Lepomis Gibbosus L.) population from small ponds along the Vit River (Bulgaria). Bulgarian Journal of Agricultural Science 14 (2): 227-234

Vörösmarty C. J., Mcintyre P. B., Gessner M. O., Dudgeon D., Prusevich A. & Green P. 2010. Global threats to human water security and river biodiversity. Nature 467: 555–561.

Welcomme R. L. 1984. International Transfers of Inland Fish Species. In: Courtenay W. R. & Stauffer J. R. (Eds): Distribution, Biology, and Management of Exotic Fishes. Baltimore: Johns Hopkins University Press, 423 p.

Welcomme R. L. 1988. International introductions of inland aquatic species. FAO Fisheries Technical Paper 294: 318 p.

WFD 2000. Directive of the European Parliament and of the Council 2000/60/EC establishing a framework for community action in the field of water policy. European Union, the European Parliament and Council, Luxembourg.

Williamson M. 1996. Biological Invasions. Chapman and Hall, New York, 244 p.

Yankova M. 2016. Alien invasive fish species in Bulgarian waters: An overview. International Journal of Fisheries and Aquatic Studies 4 (2): 282-290.

Zaret T. M. & Paine R. 1973. Species introduction in a tropical lake. Science 182: 449-455.

Zenetos A., Pancucci-Papadopoulou M.-A., Zogaris S., Papastergiadou E., Vardakas L. S, Aligizaki K. & Economou A. 2009. Aquatic alien species in Greece (2009): tracking sources, patterns and effects on the ecosystem. Journal of Biological Research-Thessaloniki 12: 135 – 172.

Zorić K., Simonović P., Đikanović V., Marković V., Nikolić V., Simić V. & Paunović M. 2014. Checklist of non-indigenous fish species of the River Danube. Archives of Biological Science 66 (2): 629-639.

Zupančič P., Marić D., Naseka A. M. & Bogutskaya N. G. 2010. *Squalius platyceps*, a new species of fish (Actinopterygii: Cyprinidae) from the Skadar Lake basin. Zoosystematica Rossica 19 (1): 154–167.

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