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Non-indigenous freshwater fish research in Greece: Current status and future prospects

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Table S1. The list of 87 fully reviewed articles.

Articles
Apostolou, A., Koutrakis, M., Pehlivanov, L., Vassilev, M., Stefanov, T. <i>et al.</i> , 2010. Notes on the fish fauna composition of Mesta (Nestos) River in regard to management and conservation. <i>Acta Zoologica Bulgarica</i> , 62 (3), 271-276.
Bobori, D.C., Salvarina, I., 2010. Seasonal variation of fish abundance and biomass in gillnet catches of an East Mediterranean lake: Lake Doirani. <i>Journal of Environmental Biology</i> , 31 (6), 995-1000.
Bobori, D.C., Tsikliras, A.C., Economidis, N.I., 2006. Some morphological and biological characteristics of fishes from Tavropos reservoir (western Greece). <i>Folia Zoologica -Praha-</i> , 55 (2), 199.
Bobori, D.C., Economidis, P.S., Maurakis, E.G., 2001. Freshwater fish habitat science and management in Greece. <i>Aquatic Ecosystem Health & Management</i> , 4 (4), 381-391.
Bobori, D.C., Salvarina, I., Michaloudi, E., 2013. Fish dietary patterns in the eutrophic Lake Volvi (East Mediterranean). <i>Journal of Biological Research</i> , 19, 139.
Bobori, D.C., Ntislidou, C., Petriki, O., Chronis, I., Kagalou, I. <i>et al.</i> , 2018. Macroinvertebrate and fish communities in the watershed of a re-constructed Mediterranean water body: link to the ecological potential. <i>Environmental Monitoring & Assessment</i> , 190 (3), 106.
Bobori, D., Petriki, O., Aftzi, C., 2019. Fish community structure in the Mediterranean temperate Lake Volvi at two different stages of pumpkinseed invasion: are natives in threat? <i>Turkish Journal of Fisheries & Aquatic Sciences</i> , 19 (12), 1039-1048.
Bounas, A., Keroglidou, M., Toli, E. A., Chousidis, I., Tsaparis, D. <i>et al.</i> , 2020. Constrained by aliens, shifting landscape, or poor water quality? Factors affecting the persistence of amphibians in an urban pond network. <i>Aquatic Conservation: Marine & Freshwater Ecosystems</i> , 30 (5), 1037-1049.
Carpio, A.J., De Miguel, R.J., Oteros, J., Hillström, L., Tortosa, F.S., 2019. Angling as a source of non-native freshwater fish: a European review. <i>Biological Invasions</i> , 21 (11), 3233-3248.
Chamoglou, M., Apostolou, A., 2019. Fish community in Karla Reservoir (Central Greece) after the filling stage. <i>Acta Zoologica Bulgarica</i> , 71 (4), 575-580.
Copp, G.H., Robert Britton, J., Cucherousset, J., Garcia-Berthou, E., Kirk, R. <i>et al.</i> , 2009. Voracious invader or benign feline? A review of the environmental biology of European catfish <i>Silurus glanis</i> in its native and introduced ranges. <i>Fish & Fisheries</i> , 10 (3), 252-282.
Corsini-Foka, M., Economidis, P.S., 2007. Allochthonous and vagrant ichthyofauna in Hellenic marine and estuarine waters. <i>Mediterranean Marine Science</i> , 8 (1), 67-90.
Crawford, S.S., Muir, A.M., 2008. Global introductions of salmon and trout in the genus <i>Oncorhynchus</i> : 1870-2007. <i>Reviews in Fish Biology & Fisheries</i> , 18 (3), 313-344.
Crivelli, A.J., 1995. Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region? <i>Biological Conservation</i> , 72 (2), 311-319.
Cucherousset, J., Horky, P., Slavík, O., Ovidio, M., Arlinghaus, R. <i>et al.</i> , 2018. Ecology, behaviour and management of the European catfish. <i>Reviews in Fish Biology & Fisheries</i> , 28 (1), 177-190.
Economidis, P.S., Dimitriou, E., Pagoni, R., Michaloudi, E., Natsis, L., 2000. Introduced and translocated fish species in the inland waters of Greece. <i>Fisheries Management & Ecology</i> , 7 (3), 239-250.

Continued

Articles

- Economou, A.N., Giakoumi, S., Vardakas, L., Barbieri, R., Stoumboudi M.T. *et al.*, 2007. The freshwater ichthyofauna of Greece-an update based on a hydrographic basin survey. *Mediterranean Marine Science*, 8 (1), 91-166.
- Economou, A.N., Zogaris, S., Vardakas, L., Koutsikos, N., Chatzinikolaou, Y. *et al.*, 2016. Developing policy-relevant river fish monitoring in Greece: Insights from a nation-wide survey. *Mediterranean Marine Science*, 17 (1), 302-322.
- Ekmekçi, F.G., Kirankaya, Ş.G., 2006. Distribution of an invasive fish species, *Pseudorasbora parva* (Temminck & Schlegel, 1846) in Turkey. *Turkish Journal of Zoology*, 30 (3), 329-334.
- Gavriloaie, C., Burlacu, L., Bucur, C., Berkesy, C., 2014. Notes concerning the distribution of Asian fish species, *Pseudorasbora parva*, in Europe. *Aquaculture, Aquarium, Conservation & Legislation*, 7 (1), 43-50.
- Gkenas, C., Oikonomou, A., Economou, A., Kiosse, F., Leonardos, I., 2012. Life history pattern and feeding habits of the invasive mosquitofish, *Gambusia holbrooki*, in Lake Pamvotis (NW Greece). *Journal of Biological Research*, 17, 121.
- Gozlan, R.E., Andreou, D., Asaeda, T., Beyer, K., Bouhadad, R. *et al.*, 2010. Pan-continental invasion of *Pseudorasbora parva*: towards a better understanding of freshwater fish invasions. *Fish & Fisheries*, 11 (4), 315-340.
- Hanel, L., Plesník, J., Andreska, J., Lusk, S., Novák, J. *et al.*, 2011. Alien fishes in European waters. *Bulletin Lampetra*, 7, 148-185.
- Holčík, J., 1991. Fish introductions in Europe with particular reference to its central and eastern part. *Canadian Journal of Fisheries & Aquatic Sciences*, 48 (S1), 13-23.
- Innal, D., 2011. Distribution and impacts of *Carassius species* (Cyprinidae) in Turkey: a review. *Management of Biological Invasions*, 2 (1), 57-68.
- Innal, D., Erk'akan, F., 2006. Effects of exotic and translocated fish species in the inland waters of Turkey. *Reviews in Fish Biology & Fisheries*, 16 (1), 39-50.
- Kagalou, I., Papadimitriou, T., Bacopoulos, V., Leonardos, I., 2008. Assessment of microcystins in lake water and the omnivorous fish (*Carassius gibelio*, Bloch) in Lake Pamvotis (Greece) containing dense cyanobacterial bloom. *Environmental Monitoring & Assessment*, 137 (1-3), 185-195.
- Kalogianni, E., Giakoumi, S., Andriopoulou, A., Chatzinikolaou, Y., 2014. Prey utilisation and trophic overlap between the non native mosquitofish and a native fish in two Mediterranean rivers. *Mediterranean Marine Science*, 15 (2), 287-301.
- Kalogianni, E., Kmentová, N., Harris, E., Zimmerman, B., Giakoumi, S. *et al.*, 2017. Occurrence and effect of trematode metacercariae in two endangered killifishes from Greece. *Parasitology Research*, 116 (11), 3007-3018.
- Kalogianni, E., Koutsikos, N., Vardakas, L., Giakoumi, S., Chatzinikolaou *et al.*, 2019. Impacts of the alien mosquitofish on the abundance and condition of two Mediterranean native fish. *Mediterranean Marine Science*, 20 (4), 727-735.
- Karaiskou, N., Lappa, M., Kalomoiris, S., Oikonomidis, G., Psaltopoulou, C. *et al.*, 2011. Genetic monitoring and effects of stocking practices on small *Cyprinus carpio* populations. *Conservation Genetics*, 12 (5), 1299-1311.
- Kokkinakis, A.K., 2007. Environmental risks of the fish fauna in the main rivers of Central Macedonia (Greece). *Journal of Environmental Protection & Ecology*, 8 (1), 107-118.
- Kolev, V., 2013. Species composition of the ichthyofauna of some tributaries of the Maritza River. *Forestry Ideas*, 19 (2), 129-139.
- Konstantinidis, E., Perdikaris, C., Vardakas, L., Paschos, I., 2018. Spatio-temporal surface variations and freshwater fish diversity in a complex of small-sized lentic ecosystems in NW Greece. *Acta Zoologica Bulgarica*, 70 (4), 575-583.
- Kostov, V., Nastova, R., Gjorgjovska, N., Ušlinovska, I., Arsovska, J. *et al.*, 2015. First record of common bream, *Abramis brama* (Linnaeus, 1758), introduced to the Vardar River Basin, Republic of Macedonia. *Macedonian Journal of Animal Science*, 5 (2) 113-118.
- Kostov, V., Ristovska, M., Arsovska, J., Jordanova, M., Prelik, D., 2016. Red-bellied Piranha *Pygocentrus nattereri* Kner, 1858 (Characiformes: Serrasalminidae) in open waters in R. Macedonia. *Ecologica Montenegrina*, 8, 64-71.

Continued

Articles

- Koutrakis, E.T., Kokkinakis, A.K., Eleftheriadis, E.A., Argyropoulou, M.D., 2000. Seasonal changes in distribution and abundance of the fish fauna in the two estuarine systems of Strymonikos gulf (Macedonia, Greece). *Belgian Journal of Zoology*, 130 (1), 41-48.
- Koutrakis, E., Sapounidis, A., Favre-Krey, L., Krey, G., Economidis, P.S., 2011. Incidental catches of Acipenseridae in the estuary of the River Evros, Greece. *Journal of Applied Ichthyology*, 27 (2), 366-368.
- Koutrakis, E., Sylaios, G., Kamidis, N., Markou, D., Sapounidis, A., 2009. Fish fauna recovery in a newly re-flooded Mediterranean coastal lagoon. Estuarine, *Coastal & Shelf Science*, 83 (4), 505-515.
- Koutsikos, N., Economou, A.N., Vardakas, L., Kommatas, D., Zogaris, S., 2017. First confirmed record of an established population of sailfin molly, *Poecilia latipinna* (Actinopterygii: Cyprinodontiformes: Poeciliidae), in Europe. *Acta Ichthyologica et Piscatoria*, 47 (3), 311-315.
- Koutrakis, E., Emfietzis, G., Sylaios, G., Zoidou, M., Katsiapi, M. *et al.*, 2016. Massive fish mortality in Ismarida Lake, Greece: Identification of drivers contributing to the fish kill event. *Mediterranean Marine Science*, 17 (1), 280-291.
- Koutsikos, N., Zogaris, S., Vardakas, L., Kalantzi, O. I., Dimitriou, E. *et al.*, 2019. Tracking non-indigenous fishes in lotic ecosystems: Invasive patterns at different spatial scales in Greece. *Science of the Total Environment*, 659, 384-400.
- Koutsikos, N., Vardakas, L., Kalogianni, E., Economou, A.N., 2018. Global distribution and climatic match of a highly traded ornamental freshwater fish, the sailfin molly *Poecilia latipinna* (Lesueur, 1821). *Knowledge & Management of Aquatic Ecosystems*, (419), 23.
- Koutsikos, N., Vardakas, L., Zogaris, S., Perdikaris, C., Kalantzi, O.I. *et al.*, 2019. Does rainbow trout justify its high rank among alien invasive species? Insights from a nationwide survey in Greece. *Aquatic Conservation: Marine & Freshwater Ecosystems*, 29 (3), 409-423.
- Koutsikos, N., Zogaris, S., Vardakas, L., Tachos, V., Kalogianni, E. *et al.*, 2012. Recent contributions to the distribution of the freshwater ichthyofauna in Greece. *Mediterranean Marine Science*, 13 (2), 268-277.
- Leonardos, I.D., Kagalou, I., Tsoumani, M., Economidis, P.S., 2008. Fish fauna in a Protected Greek lake: biodiversity, introduced fish species over a 80-year period and their impacts on the ecosystem. *Ecology of Freshwater Fish*, 17 (1), 165-173.
- Leonardos, I.D., Tsikliras, A.C., Eleftheriou, V., Cladas, Y., Kagalou, I. *et al.*, 2008. Life history characteristics of an invasive cyprinid fish (*Carassius gibelio*) in Chimaditis Lake (northern Greece). *Journal of Applied Ichthyology*, 24 (2), 213-217.
- Leonardos, I.D., Tsikliras, A.C., Batzakas, I., Ntakos, A., Liouisia, V., 2009. Life-history characteristics of the endangered Aristotle's catfish (*Silurus aristotelis* Garman, 1890), Lake Pamvotis, north-western Greece. *Journal of Applied Ichthyology*, 25 (6), 746-751.
- Liasko, R., Anastasiadou, C., Ntakos, A., Gkenas, C., Leonardos, I.D., 2012. Morphological differentiation among native trout populations in North-Western Greece. *Journal of Biological Research*, 17, 33.
- Marr, S.M., Olden, J.D., Leprieur, F., Arismendi, I., Čaleta, M. *et al.*, 2013. A global assessment of freshwater fish introductions in mediterranean-climate regions. *Hydrobiologia*, 719 (1), 317-329.
- Meulenbroek, P., Shumka, S., Schiemer, F., 2018. First reconnaissance of habitat partitioning and fish diversity in the alluvial zone of the river Vjosa, Albania. *Acta ZooBot Austria*, 155, 177-186.
- Oikonomou, A., Leprieur, F., Leonardos, I.D., 2018. Ecomorphological diversity of freshwater fishes as a tool for conservation priority setting: a case study from a Balkan hotspot. *Environmental Biology of Fishes*, 101 (7), 1121-1136.
- Ozcan, G., 2007. Distribution of non-indigenous fish species, Prussian carp *Carassius gibelio* (Bloch, 1782) in the Turkish freshwater systems. *Pakistan Journal of Biological Sciences: PJBS*, 10 (23), 4241-4245.
- Ozulug, M., Gaygusuz, O., Gaygusuz, C.G., Sac, G., 2019. New distribution areas of four invasive freshwater fish species from Turkish Thrace. *Turkish Journal of Fisheries & Aquatic Sciences*, 19 (10), 837-845.
- Papastergiadou, E., Kagalou, I., Stefanidis, K., Retalis, A., Leonardos, I., 2010. Effects of anthropogenic influences on the trophic state, land uses and aquatic vegetation in a shallow Mediterranean lake: implications for restoration. *Water Resources Management*, 24 (3), 415-435.
- Papavlasopoulou, I., Vardakas, L., Perdikaris, C., Kommatas, D., Paschos, I., 2014. Ornamental fish in pet stores in Greece: a threat to biodiversity? *Mediterranean Marine Science*, 15 (1), 126-134.

Continued

Articles

- Paschos, I., Perdikaris, C., Gouva, E., Nathanailides, C., 2008. Sturgeons in Greece: a review. *Journal of Applied Ichthyology*, 24 (2), 131-137.
- Perdikaris, C., Ergolavou, A., Gouva, E., Nathanailides, C., Chantzaropoulos, A. *et al.*, 2012. *Carassius gibelio* in Greece: the dominant naturalised invader of freshwaters. *Reviews in Fish Biology & Fisheries*, 22 (1), 17-27.
- Perdikaris, C., Gouva, E., Paschos, I., 2010. Alien fish and crayfish species in Hellenic freshwaters and aquaculture. *Reviews in Aquaculture*, 2 (3), 111-120.
- Perdikaris, C., Koutsikos, N., Vardakas, L., Kommatas, D., Simonović, P. *et al.*, 2016. Risk screening of non-native, translocated and traded aquarium freshwater fishes in Greece using Fish Invasiveness Screening Kit. *Fisheries Management & Ecology*, 23 (1), 32-43.
- Petriki, O., Lazaridou, M., Bobori, D.C., 2017. A fish-based index for the assessment of the ecological quality of temperate lakes. *Ecological Indicators*, 78, 556-565.
- Piria, M., Simonović, P., Kalogianni, E., Vardakas, L., Koutsikos, N. *et al.*, 2018. Alien freshwater fish species in the Balkans-Vectors and pathways of introduction. *Fish & Fisheries*, 19 (1), 138-169.
- Reyjol, Y., Hugueny, B., Pont, D., Bianco, P.G., Beier, U. *et al.*, 2007. Patterns in species richness and endemism of European freshwater fish. *Global Ecology & Biogeography*, 16 (1), 65-75.
- Ribeiro, F., Leunda, P.M., 2012. Non-native fish impacts on Mediterranean freshwater ecosystems: current knowledge and research needs. *Fisheries Management & Ecology*, 19 (2), 142-156.
- Rosecchi, E., Crivelli, A. J., Catsadorakis, G., 1993. The establishment and impact of *Pseudorasbora parva*, an exotic fish species introduced into Lake Mikri Prespa (north-western Greece). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 3 (3), 223-231.
- Rylková, K., Kalous, L., Bohlen, J., Lamatsch, D.K., Petrýl, M., 2013. Phylogeny and biogeographic history of the cyprinid fish genus *Carassius* (Teleostei: Cyprinidae) with focus on natural and anthropogenic arrivals in Europe. *Aquaculture*, 380, 13-20.
- Shumka, S., Apostolou, A., 2018. Current knowledge on the status of the most common non-indigenous fish species in the trans-boundary Greater Prespa Lake (Albanian Side). *Acta Zoologica Bulgarica*, 70, 203-209.
- Sommerwerk, N., Wolter, C., Freyhof, J., Tockner, K., 2017. Components and drivers of change in European freshwater fish faunas. *Journal of Biogeography*, 44 (8), 1781-1790.
- Stoumboudi, M.T., Barbieri, R., Kalogianni, E., 2017. First report of an established population of *Oncorhynchus mykiss* (Walbaum, 1792) (Salmonidae) on the Island of Crete, Greece. *Acta Zoologica Bulgarica*, 9, 99-104.
- Takada, M., Tachihara, K., Kon, T., Yamamoto, G., Iguchi, K.I. *et al.*, 2010. Biogeography and evolution of the *Carassius auratus*-complex in East Asia. *BMC Evolutionary Biology*, 10 (1), 7.
- Tarkan, A.S., Copp, G.H., Top, N., Özdemir, N., Önsoy, B. *et al.*, 2012. Are introduced gibel carp *Carassius gibelio* in Turkey more invasive in artificial than in natural waters? *Fisheries Management & Ecology*, 19 (2), 178-187.
- Tarkan, A.S., Marr, S.M., Ekmekçi, F.G., 2015. Non-native and translocated freshwater fish. *FiSHMED Fishes in Mediterranean Environments*, 3, 28.
- Tricarico, E., 2012. A review on pathways and drivers of use regarding non-native freshwater fish introductions in the Mediterranean region. *Fisheries Management & Ecology*, 19 (2), 133-141.
- Tsoumani, M., Liasko, R., Moutsaki, P., Kagalou, I., Leonardos, I., 2006. Length-weight relationships of an invasive cyprinid fish (*Carassius gibelio*) from 12 Greek lakes in relation to their trophic states. *Journal of Applied Ichthyology*, 22 (4), 281-284.
- Turchini, G.M., De Silva, S.S., 2008. Bio-economical and ethical impacts of alien finfish culture in European inland waters. *Aquaculture International*, 16 (3), 243-272.
- Uzunova, E.P., Georgieva, M., Pavlova, M.N., Studenkov, S., Popov, V., 2012. Variation of abundance and demographic structure of the introduced pumpkinseed, *Lepomis gibbosus* (Actinopterygii: Perciformes: Centrarchidae), in relation to littoral habitats and water body use. *Acta Ichthyologica et Piscatoria*, 42 (2), 121.

Continued

Articles

- Uzunova, E., Studenkov, S., Dashinov, D., 2019. First records of largemouth bass *Micropterus salmoides* (Lacépède, 1802) from Bulgaria (Balkan Peninsula). *BioInvasions Records*, 8 (2), 427-436.
- Vanhove, M.P., Kovačić, M., Koutsikos, N.E., Zogaris, S., Vardakas, L.E. *et al.*, 2011. First record of a landlocked population of marine *Millerigobius macrocephalus* (Perciformes: Gobiidae): observations from a unique spring-fed karstic lake (Lake Vouliagmeni, Greece) and phylogenetic positioning. *Zoologischer Anzeiger-A Journal of Comparative Zoology*, 250 (3), 195-204.
- Vardakas, L., Kalogianni, E., Zogaris, S., Koutsikos, N., Vavalidis, T. *et al.*, 2015. Distribution patterns of fish assemblages in an Eastern Mediterranean intermittent river. *Knowledge & Management of Aquatic Ecosystems*, (416), 30.
- Vilizzi, L., 2012. The common carp, *Cyprinus carpio*, in the Mediterranean region: origin, distribution, economic benefits, impacts and management. *Fisheries Management & Ecology*, 19 (2), 93-110.
- Vilizzi, L., Copp, G.H., Adamovich, B., Almeida, D., Chan, J. *et al.*, 2019). A global review and meta-analysis of applications of the freshwater Fish Invasiveness Screening Kit. *Reviews in Fish Biology & Fisheries*, 29 (3), 1-40.
- Villeneuve, F., Copp, G.H., Fox, M. G., Stakénas, S., 2005. Interpopulation variation in growth and life-history traits of the introduced sunfish, pumpkinseed *Lepomis gibbosus*, in southern England. *Journal of Applied Ichthyology*, 21 (4), 275-281.
- Yavno, S., Gobin, J., Wilson, C. C., Vila-Gispert, A., Copp, G.H. *et al.*, 2020. New and Old World phylogeography of pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758): the North American origin of introduced populations in Europe. *Hydrobiologia*, 847 (2), 345-364.
- Yerli, S. V., Mangit, F., Emiroğlu, Ö., Yeğen, V., Uysal, R. *et al.*, 2014. Distribution of Invasive *Carassius gibelio* (Bloch, 1782) (Teleostei: Cyprinidae) in Turkey. *Turkish Journal of Fisheries & Aquatic Sciences*, 14 (2), 581-590.
- Zenetos, A., Pancucci-Papadopoulou, M., Zogaris, S., Papastergiadou, E., Vardakas, L. *et al.*, 2009. Aquatic alien species in Greece (2009): tracking sources, patterns and effects on the ecosystem. *Journal of Biological Research*, 12, 135-172.
- Zogaris, S., Apostolou, A., 2011. First record of Pontian Monkey Goby, *Neogobius fluviatilis* (Pallas, 1814) in the Evros River (Greece); Is it an alien species? *Mediterranean Marine Science*, 12 (2), 454-461.
- Zogaris, S., Ntakos, A., Barbieri, R., 2019. The racer goby, *Babka gymnotrachelus* (Kessler, 1857) invades the Evros river: evidence of recent establishment in Greece. *Knowledge & Management of Aquatic Ecosystems*, (420), 13.