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Patterns and drivers of aquarium pet discharge in the wild

F. Banha[a,*], A. Diniz[b], P.M. Anastácio[a]

[a] MARE – Marine and Environmental Sciences Centre, Departamento de Paisagem, Ambiente e Ordenamento, Escola de Ciências e Tecnologia, Universidade de Évora, Évora, Portugal
[b] Departamento de Psicologia, Escola de Ciências Sociais, Universidade de Évora, Évora, Portugal

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ABSTRACT

Aquarium pets release is an important vector for invasive species establishment in freshwater ecosystems. Here the perceptions and risk behaviors associated to this vector were evaluated using a survey. Portuguese aquarium hobbyists were interviewed through an on-line survey (Google forms) publicized in 9 web sites connected to this hobby (Facebook pages and internet forums). A Pet Propagule Pressure index (PPP), congregating information regarding pet's popularity and electivity for discharge, was developed and applied in this study, so that relative comparisons can be made among different pet types (taxa). Additionally, non-metric Multidimensional Scaling (nMDS) was applied to pet owner's data to identify indicator factors associated with risk behaviors and impacts' awareness.

Results indicated that aquarium pet owners usually only have one pet type, most commonly fish or turtles. Only 8% of the owners admit having discharged pets, being more commonly reported the release of only one pet. This risk behavior is connected mainly to the excessive growth of the pet and consequently lack of space in the aquariums. Pet's discharge occurs until 100 km of distance from owner's homes, being very common at distances lower than 1 km. The PPP index developed in this study, indicates the pet types with higher risk of discharge were the turtles and the fishes. Pet owner's awareness regarding the pet discharges impacts in the environment seems to be lower than other risk groups connected to biological invasions in freshwaters, namely anglers. Pet owners most aware of these impacts were associated to higher education levels and higher experience on this hobby.

Our study highlights the needs for more environmental education on particular social groups within aquarium pets' owners, namely those that have started this activity or have lower education levels, to decrease the biological invasion risks associated to this hobby. Additionally, our findings regarding the patterns and drivers of discharge action itself are useful to model risk invasion, as well as for detection, management and control of these species.

1. Introduction

Freshwater ecosystems are one of the most important ecosystems for humankind and also one of the main reservoirs of biodiversity in the world (Costanza et al., 1997). Yet, these ecosystems have been suffering one of the major biodiversity declines of the earth (Millennium Ecosystem, 2005; Dudgeon et al., 2006). One of the main reasons for this, are biological invasions (Ricciardi and MacIsaac, 2000; Sala et al., 2000). In the invasion process the non-indigenous species (NIS) also cause other negative impacts, namely socio-economic, with severe losses (e.g. EEA, 2012). Freshwater NIS use several pathways or vectors, especially for secondary spread (see Banha et al., 2014; Banha and Anastácio, 2015; Banha et al., 2016b). However, the primary introduction pathways are not so numerous, being aquarium pet release one of the most important (Padilla and Williams, 2004; Kraus, 2009; Maceda-Veiga et al., 2016). Associated with these intentional introductions, there is a vast list of organisms accidentally transported as contaminants or "hitchhikers" (Duggan et al., 2018; Patoka et al., 2016a,b). The ornamental use of wild animals (e.g. for human entertainment or companionship) has been part of human culture since prehistory (Driscoll and Macdonald, 2010). This activity strongly impacts biodiversity, since it uses many native and endangered species (Patoka et al., 2017a,b). In the last decades the demand for pets increased exponentially and it is expected to continue to growth (Dickman et al., 2007). The economic importance of its trade also increased exponentially, involving both developed countries (mainly

* Corresponding author at: MARE – Marine and Environmental Sciences Centre, Departamento de Paisagem, Ambiente e Ordenamento, Escola de Ciências e Tecnologia, Universidade de Évora, R. Romão Ramalho, 59, 7000-671 Évora, Portugal.
E-mail address: filipebanha@uevora.pt (F. Banha).

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