

When reintroduction turns to invasion: a fable about turtles and crayfish

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Alien species enter new areas through a variety of pathways, but always directly or indirectly through human activity. If an alien species manages to reproduce successfully, it may become invasive, with potential far-reaching negative consequences for humans and the environment. The calico crayfish *Faxonius immunis* has an extreme invasion potential due to its capability to walk long distances overland, its high fecundity and early sexual maturity in first summer, and its habit to dig deep corridors in the sediment where it can survive drought and frost. In addition, it is a vector of a highly virulent strain of the crayfish plague disease agent *Aphanomyces astaci*. Calico crayfish has successfully established in Southwestern Germany since 1997 and bordering Northeastern France since 2013. Biological invasions contrast with species reintroductions, which are conservation strategies where native species are deliberately returned into their original habitat. Such a reintroduction project is being carried out within the trans-bordering area between Neuburg am Rhein, Germany, and Lauterbourg, France, where wetlands have been restored since 2011 in favor of the protected European pond turtle *Emys orbicularis*. Here, the long-term success of the reintroduction of this umbrella species can be impacted by the calico crayfish presence through alteration of the habitat structure and food web. This study investigates i) the macrophyte and macroinvertebrate communities since the calico crayfish was first sighted in the area, and ii) the trophic interactions between the turtle and the calico crayfish. Crayfish monitoring revealed a significant expansion of the calico crayfish throughout the study area. Hydrobiological assessments showed that all water bodies, both natural and restored, turned highly turbid due to sediment mobilization by burrowing calico crayfish. Concurrently, both aquatic flora and fauna dramatically declined in terms of species diversity and abundance. However, we showed with eDNA analysis of fecal samples and prey choice tests that turtles prey on calico crayfish in the wild and in captivity. Since the relevance of reintroductions as ex-situ management procedures are nowadays highly debated, our results suggest the potential biological control of the invasive calico crayfish by reintroduced turtles.

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