frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 11 April 2023
DOI 10.3389/fenvs.2023.1190398

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Freshwater Science,
a section of the journal
Frontiers in Environmental Science

RECEIVED 20 March 2023
ACCEPTED 29 March 2023
PUBLISHED 11 April 2023

CITATION
Rosso JJ, Langerhans RB and Avigliano E (2023), Editorial: Fish as sentinels of urbanization impacts in aquatic ecosystems.
Front. Environ. Sci. 11:1190398.
doi: 10.3389/fenvs.2023.1190398

Editorial: Fish as sentinels of urbanization impacts in aquatic ecosystems

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KEYWORDS

freshwater fishes, marine ecosystems, phenotypes, alien species, mangroves, habitat degradation, assemblage homogenisation, lamprey

Editorial on the Research Topic
Fish as sentinels of urbanization impacts in aquatic ecosystems

By 2030, urban areas are projected to house 60 per cent of people globally (United Nations, 2018). Cities tend to occur near water because of the fundamental need for freshwater, but also because of its diverse uses (travel, commerce, food production, power generation, flood management). In this context, urbanized landscapes represent a major threat to freshwater (Albert et al., 2020) and marine (Alter et al., 2020) organisms. Being one of the only vertebrates that inhabit all types of aquatic ecosystems, fish are good candidates to serve as sentinels of the impacts of urbanization.

This topic Research Topic includes five key contributions examining changes in fish assemblages, populations and phenotypes, and their potential ecological, evolutionary and economic consequences caused by urban-induced changes. Major patterns in fish responses to urbanization may vary among species, type of aquatic ecosystems and biogeographic regions, and this was supported by the contributions of this topic including studies from diverse fish taxa, aquatic environments and regions around the world. Nearctic, Neotropical and Austral fish assemblages are covered as well as freshwater and marine ecosystems. The studies document important changes in fish facing urbanization at varying spatial and temporal scales.

Temporal changes in taxonomic and functional diversity in the fish assemblage of an urban stream in Texas were assessed (Antoniazzi et al.) over a 30 year period (1989–1990 vs. 2018–2019). The occurrence of previously absent species resulted in increased functional diversity in the modern, more urbanized, time period. But certainly, these were not good news. The increase in functional diversity was supported by the addition of invasive generalist (e.g., blue tilapia) and native tolerant (e.g., redbreast sunfish, blacktail shiner) species. As these species were locally common in present-day assemblages, some sensitive sentinel species as Sabine shiner (*Notropis sabinae*) and blackspot shiner (*N. atrocaudalis*) were extirpated or drastically reduced responding to stream alterations. Moreover, all native invader species increased their abundance with urbanization. Indeed, worldwide freshwater fish homogenization is strongly determined by the species

translocated within a realm (Toussaint et al., 2016). Nevertheless, this might change in the future as urbanization can increase the invasive potential of alien species (Marques et al., 2020).

Physical alterations derived from urbanization on aquatic ecosystems and their impacts on fish assemblages were assessed in two disparate and distinct geographic and environmental scenarios.

A study in the Biscayne Bay (an urban bay in Southeast Florida) explored if fish formed distinct species assemblages when intact mangrove shorelines are compared with mangrove sites altered by drainage canals or residential marinas (Lennon and Sealey). Contrary to what was expected, shoreline condition did not appear to be relevant for fish assemblages. Some degree of shoreline alteration did not affect the surrounding mangroves' ability to support fish assemblages. Instead, water depth and salinity were intimately correlated with distinct clusters of fish assemblages. As altered mangroves had greater salinities and depths than intact mangrove, perhaps as a consequence of dredging, the cluster of fish assemblages positively associated with these variables were composed of marine species. A historical shift from estuarine to marine species was observed in Biscayne Bay so restoration practices in altered mangroves intended to reduce their impacts on water depth and salinity would help to recover the original estuarine fish assemblage. Coastal urbanization landscapes represent a challenge for management interventions (Baird, 2009).

In the lower basin of the Andalién River in Central Chile, a century of anthropogenic river alterations drastically reduced the diverse fish fauna from 16 to 9 species (Moraga et al.). The study, which compiled records from 1919 to 2018, reported the extirpation of the two migratory lampreys, one of them endemic. Conversely, the invasive species *Gambusia holbrooki*, first registered in 1999, is currently the most abundant in the urban zone of this river. These changes were attributed to alterations in river morphology with the removal of specific habitats and changes in flow, water quality, and sediment regime. The new homogenized habitat conditions are ideal for many exotic fish species but detrimental to the native fish and lamprey fauna. Habitat loss is the most pernicious impact derived from human pressure on South American aquatic ecosystems (Barletta et al., 2010). An urban planning with strong modifications of the river bed at lower reaches and intense agricultural and forestry activities at middle basin sectors were postulated as the main causes for the loss of resilience in this river ecosystem.

Urbanization also has shown strong deleterious effects on important phenotypic aspects related to reproduction in some fish populations (Marques et al.). The expression of color (pre-mating trait) and sperm load (post-mating trait) in a small viviparous fish was influenced by urbanization. Moreover, there was a differential expression of colors depending on body size. Namely, small urban guppies (*Poecilia reticulata*) presented a reduction in the expression of orange color whereas the same was true for the expression of iridescent colors in large urban guppies. Interestingly, urbanization also affected the relationship between color and sperm load but such a relationship was context dependent. Orange color was positively related to sperm load in urban guppies, but the iridescent colors showed a positive relationship to sperm load in non-urban guppies suggesting that males relied on different colors to signal fertility to females. Altered optical environment in urban systems also have significant effects on melanin-based colour signals (Côte et al., 2019).

One of the contributions reviewed the use of isotope-based methods for studying urbanization impacts on freshwater fish populations (Burbank et al.). Traditionally, fish populations were assessed by means of survival, growth and reproductive metrics (Power, 2002). This review showed that several key aspects of ecological and physiological impacts of urban development on freshwater fishes can be addressed by these methods. Particularly, authors show that urbanization impacts on feeding ecology, habitat and thermal occupancy and field metabolic rates of freshwater fishes can be assessed by means of stable isotopes. A comprehensive summary and analysis of stable isotope-based approaches proposed for evaluating urbanization impacts on freshwater fishes, the isotopes commonly used for each approach, and useful R packages that can be used to implement each approach is presented.

Author contributions

All authors conceived the Research Topic. JJR wrote the first draft of the Editorial manuscript. RBL and EA revised and improved the manuscript. All authors approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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