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The development of an environmental DNA method to assess estuarine fish biodiversity

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Abstract

The ecological quality of estuaries is assessed in the United Kingdom under the Water Framework Directive by monitoring key ecological groups, including fish. Fish surveys currently use seine and fyke nets, and beam trawls. Comparably, Environmental DNA (eDNA) metabarcoding may be a non-invasive, cost-effective, complementary method. However, its application to fishes in estuaries is understudied. We present a comprehensive assessment of the effectiveness of eDNA metabarcoding to survey estuarine fish biodiversity at multiple spatial and temporal scales. Firstly, we investigated the ability of eDNA to detect a spatial transition from a freshwater to marine fish assemblage across seasons. Triplicate water samples were taken at stations along a transect on the Dee estuary, during October 2018 (15 stations) alongside netting methods, and in June 2019 (11 stations). Secondly, we assessed short-term tidal variability in fish assemblage eDNA. Duplicate samples were taken at one station on the Conwy at high and low tide over 15 days (30 events) covering a spring to neap tide in Autumn 2020. Thirdly, we investigated variation in assemblage composition from eDNA between three estuaries, across seasons, alongside netting methods. Triplicate samples were taken along transects in the Esk (4 stations), Tweed (3-4 stations) and Tees (2 stations) in spring and autumn 2017, and autumn 2016 for the Esk and Tees. Water samples were filtered, eDNA extracted and metabarcoding conducted using 12S rRNA with Illumina® sequencing. Results will be presented with reference to contemporary and historical netting data. Preliminary analysis from the third, inter-estuarine, study suggests eDNA detects twice as many species as netting, including species of conservation interest e.g. European river lamprey. In addition, it maybe that eDNA captures spatial and temporal variation more effectively than netting methods. We therefore present emerging evidence that eDNA is an effective method of assessing the biodiversity of fishes in estuaries.

Keywords

Environmental DNA, Biomonitoring, Fishes, Water Framework Directive