Using γ-emitting artificial radionuclides, released by nuclear plants, as markers of restricted movements by chub, *Leuciscus cephalus*, in a large river, the Lower Rhône

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Synopsis

On the basis that γ-emitting artificial radionuclides, present in nuclear plant radioactive wastes, can be considered as ‘natural’ collective markers of fish living downstream from a radioactive discharge, we studied the restricted movements of chub in a reservoir on the Lower Rhône river where the Marcoule nuclear plant is located. A qualitative determination, based on the detection of specific radioelements in our samples originating from radioactive waste, and a quantitative determination of the cesium-137 concentration in the samples, were used to identify fish radioactively marked by the effluent. Individual measurements of γ-radioactivity in 49 adult chub captured at two stations, each 2 km long and 6 km apart, divided the fish into two distinct sub-units: one living downstream of the discharge pipe, in which 73% were marked, and the other upstream, in which 79% were not marked. Similar results were found in two neighbouring stations when we analysed previous radioecological measurements of γ-radioactivity in groups of chub. After combining all the data concerning chub, detailed information was obtained on the spatial stability of the chub population in the reservoir. Two spatially different stocks were found and each stock can be divided in two components: a sedentary component that remains in a restricted zone (its home range), and a mobile component that undertakes movements between the two zones.

Introduction

There is little current information on the spatial stability and structure of fish populations in large rivers. The usual capture-, mark-recapture methods, which some authors have used to study the home range and homing behaviour of fish in small streams (Gerking 1950, 1953, 1959, Stott 1961, 1967, Philippart 1977), are not very suitable in huge ecosystems as large rivers, and may yield random results. However, Williams (1965) showed that a majority of fish remained in a restricted zone in the river Thames. Hesse (1982) and Reynolds (1983) also showed evidence of major longitudinal displacements by some species and of a sedentary nature for others, in the Missouri and Murray-Darling rivers, respectively. Funk (1955) showed, for the first time, that fish populations in the Missouri river could be separated into two components: mobile and sedentary. But these authors had to mark many thousand fish because of the very low recapture rate. Telemetry, or radiotracking, is another method for studying fish
movements, but results on fish populations in large rivers are rare. Tyus (1985) studied the longitudinal breeding migrations of the Colorado squawfish, *Ptychocheilus lucius*, and Baras (1990) revealed the homing behaviour of a female barbel, *Barbus barbus*. But only a few large fish can be studied in this way, and radiotracking is not easily applicable in large rivers which are deep and turbid (Gueneau 1986). Another possible method for studying the spatial stability and movements of fish populations in large rivers, is to use natural markers which provide a clear distinction between each population or each stock.

This work is based on radioecological studies that