COEXISTENCE OF THE EURASIAN PERCH (Perca fluviatilis) AND AN INTRODUCED POPULATION OF RUFFE (Gymnocephalus cernus): AN 11 YEAR STUDY

Ian J. Winfield, Janice M. Fletcher, and J. Ben James, CEH Windermere, The Ferry House, Far Sawrey, Ambleside, Cumbria LA22 0LP, U.K., jw@ceh.ac.uk

Introduction. Competitive interactions between Eurasian perch (Perca fluviatilis) and ruffe (Gymnocephalus cernus) have been the subject of a number of experimental studies in the laboratory and field (e.g. Bergman & Greenberg 1994), although relevant long-term observations of population dynamics are notably lacking. The need for such population studies has increased in recent years due to the accidental introduction of ruffe to new water bodies in its native Europe and in North America, with consequent concerns over impacts on native fish communities.

A number of such introductions have occurred in water bodies holding native perch populations in the U.K., probably as a result of anglers live-baiting for pike (Esox lucius), including the first recording of the ruffe in Bassenthwaite Lake in north-west England in 1991 (Winfield et al. 1996). This lake, from which removal fisheries are absent, has been subject to extensive monitoring since 1990, making it a particularly appropriate site for the investigation of the impact of introduced ruffe on perch, although the situation is complicated by the fact that the cyprinids roach (Rutilus rutilus) and dace (Leuciscus leuciscus) also have been recently introduced.

The objectives of this study were to examine the population biology of perch in Bassenthwaite Lake for any changes since the first recording of ruffe in 1991, and if such changes exist to investigate if there is any evidence that they are the result of competitive interactions between these two species.

Methods. The fish community of the culturally eutrophic Bassenthwaite Lake (54° 39' N, 3° 13' W; surface area 528 ha; maximum depth c. 19 m; mean depth c. 5 m) was first assessed by annual overnight survey gill netting at 2 sites in 1991 and has subsequently been monitored using this technique at these and three additional sites from 1995 to 2002. Community composition by numbers and species catch-per-unit-efforts (number of individuals per net per night) were calculated for major species at a single inshore site (National Grid Reference NY 216 284) which had been consistently sampled throughout the study. All fish sampled in this way were subsequently identified, measured, weighed and a stratified sub-sample aged using the opercular bone. Fish from all sites were used to produce length frequency distributions and fitted von Bertalanfy growth curves, although only those for perch are presented here.

In addition, the diet compositions of perch, ruffe and roach sampled by gill nets in May, July and September 1991 and June, July and August 1995 were determined by numerical and frequency of occurrence methods.

Results. Over the study period, perch comprised between 26% and 77% of the fish community by numbers (Figure 1), while ruffe increased in relative abundance from 2% on their first detection in 1991 to 33% in 2002. The relative abundance of roach declined from 53% to 18% over the same period, with all other species consistently comprising no more than 16% in total. Dace were first detected at this inshore site in 1999, when they comprised 14% of the community. The catch-per-unit effort of perch and ruffe increased over the study period, while that of roach showed no consistent trend.

The length frequency distribution of perch showed a great increase in diversity between 1991, when it was extremely truncated with few individuals in excess of 170 mm, and 2002 by which time a series of discrete length classes was present and individuals in excess of 250 mm were common (Figure 2).

Growth curves (Figure 3) revealed that the restricted perch length frequency distribution in 1991 was the result of extremely poor growth, which subsequently increased greatly in rate and ultimate length to recover to the level previously recorded in 1986 by Mubamba (1989). Growth rate and ultimate length peaked in the late 1990s, whereas perch sampled in 2002 showed the greatest longevity.

The diet of perch (46 to 163 mm, n=73) was dominated by Daphnia, with some Asellus and chironomid larvae and pupae. In contrast, ruffe diet (56 to 144 mm, n=70) was dominated by chironomid larvae, with some chironomid pupae, Daphnia,
Figure 2. Length frequency distributions (total sample size 1380 individuals) of perch from all sites in 1991 and 1995 to 2002.

Figure 3. Growth curves (solid lines) of perch from all sites in 1991 and 1995 to 2002. The growth curve in 1986 (data from Mubamba (1989)) is shown as a broken line.

Asellus and other benthos. The diet of roach (75 to 338 mm, n=33) was dominated by Daphnia, with some chironomid larvae and filamentous algae.

Discussion. The fish community of Bassenthwaite Lake is now far removed from its original composition due to introductions of ruffe, roach and dace, followed by their population expansions to the extent that introduced species account for up to 62% of the inshore fish community.

The environment of Bassenthwaite Lake has also changed over the study period. Between 1991 and 2002, the mean annual water temperature increased significantly ($r^2=0.387, n=12, p<0.05$; CEH Windermere, unpublished data) and Seechi depth showed a decreasing but non-significant trend ($r^2=0.208, n=12, p>0.10$; CEH Windermere, unpublished data). The competitive balance between perch and ruffe is known to be strongly influenced by environmental factors such that the observed trends in the abiotic and biotic environment of Bassenthwaite Lake are likely to have favoured perch over ruffe. However, the changes were relatively modest in extent and so are unlikely to have been exclusively responsible for the observed dramatic increases in perch relative and absolute abundances, growth rate and length diversity.

These changes in perch population biology clearly show no signs of adverse impacts by the introduced ruffe population through competition or any other means. Thus, the two percids are able to coexist in Bassenthwaite Lake even though the latter species now accounts for up to 33% of the inshore fish community. Moreover, the low diet overlap observed between the two species also refutes a competition hypothesis. In contrast, diet overlap was very high between perch and introduced roach due to common consumption of Daphnia. Competition for cladoceran prey between the latter two species under eutrophic conditions often results in depressed perch populations. I is suggested that such a situation existed in Bassenthwaite Lake at the start of the present study period, resulting in a depressed growth rate and truncated length distribution of perch. During the later 1990s, competitive pressure from roach may have been reduced, allowing the recovery of the perch to conditions shown in 1986 before the significant development of introduced populations. The immediate mechanism for this hypothesized reduction in competitive pressure may have been a series of years of very poor or no roach recruitment (CEH Windermere, unpublished data), although the reason for this observed recruitment failure is unknown.

Acknowledgements. Thanks to many colleagues, past and present, for their help in the field and for giving access to unpublished environmental data. Components of this work were funded by the Natural Environment Research Council, Environment Agency, United Utilities and English Nature.

