Migrations of juvenile and subadult fish through a fishpass during late summer and fall

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A b s t r a c t . Significant numbers of juvenile (age 0+) and subadult (age 1+ and 2+) fish were observed migrating through a lowland pool fish pass (Elbe River, Czech Republic) from August to October in 2003 and 2004. Records of weekly catches totalled 2 148 (2003) and 6 469 (2004), mainly bleak *Alburnus alburnus*, barbel *Barbus barbus*, roach *Rutilus rutilus* and dace *Leuciscus leuciscus*. Fish migrated in the upstream direction probably to search the feeding grounds and refuges and their numbers corresponded to spring spawning migrations in the same fishpass and the year.

Key words: migration, fishway, cyprinids, juveniles

Introduction

Fish periodically utilize fishpasses for several purposes. Looking for suitable spawning grounds and compensation of larval drift are considered as the most important reasons (R e i c h a r d 2002), for which fish passage utilities are mainly built. Feeding and refuge-seeking migration may occur with similar intensity in different parts of a year (L u c a s & B a r a s 2001). Age spectrum of migrants reflects migration causes and immature individuals may represent a significant portion of migrants (L u c a s 2000). However, in depth information on mass migration other than spawning migration has not been published yet.

This paper describes the late summer and fall migration of juvenile and subadult fish through a lowland pool fishpass. We encountered this phenomenon during a large-scale study of the fishpass oriented to the effectiveness of fish passage with respect to environmental conditions (see P r c h a l o v á et al. 2006a, 2006b).

Methods and Material

The study was conducted in the Střekov lowland pool fishpass situated at 321 Rkm of the Elbe River, Czech Republic (catchment area 148 268 km^2). The fishpass consists of 45 concrete pools – seven of them are resting pools, which are extended in length. Standard pools are

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3 m long, 2 m wide and 1.2 m deep. The barriers between pools have two diagonally located orifices (0.3 × 0.3 m). The head between pools is 0.2 m. Total length of the fishpass is 250 m and the vertical height between the fishpass exit and the entrance is 9 m. Average discharge in the pass is 0.4 m^3s^{-1}. The fishpass is constructed only for upstream migration – it is highly improbable to find the 1-m wide fishpass exit (upstream entrance for downstream migration, respectively) by fish because of its perpendicular position to the main channel with three weir overflows and two locks. The upstream direction of fish migration through this fishpass was confirmed by observation with the fish counter (P r c h a l o v á et al. 2006a).

Direct fish sampling in the fishpass was carried out every week from 6 August to 5 November 2003 and from 9 August to 16 November 2004 (particular dates in Table 1 and Fig. 1) by draining the fishpass and collecting fish in the last chamber above the water level. Fish were identified and measured for standard lengths (SL) to the nearest mm and released. The same sampling design was used during spring monitoring of the fishpass (P r c h a l o v á et al. 2006a, 2006b). The t-tests were calculated by Statistica software. 0+ fish (i.e. SL less than 80 mm) were excluded from the test on the background of potential bias derived from comparison the size of the fish from the spring (no 0+ fish present) with late summer-fall community (0+ fish present).

Table 1. Number of fish of the most abundant species during the study period in 2003 and 2004 and during the spring spawning migration in both years (∑ Spring; 9 catches during April – May in both years).

2003 / Species	6 Aug	14 Aug	18 Aug	25 Aug	15 Sep	22 Sep	8 Oct	15 Oct	5 Nov	∑	∑ Spring
Bleak		28	3	219	268	90		37	1	646	995
Barbel	11	13	35	31	7	4	41	327	1	470	6
Roach			5	7	11	336	56	14	8	437	649
Dace	2	37	80	18	3	13	85	178	2	418	2
Perch	2	2		41	4	2	1	5		57	-
Nase						2	1	30		33	22
Chub	8	2	7	5		2	2	1	6	33	217
Other species	2	15	7	21	1	0	5	2	1	54	535
No. of species	6	9	8	9	6	7	8	8	6	14	16
Total	25	97	137	342	294	449	191	594	19	2148	2426

2004 / Species	9 Aug	20 Aug	27 Aug	2 Sep	13 Sep	23 Sep	1 Oct	19 Oct	26 Oct	5 Nov	16 Nov	∑	∑ Spring
Bleak	5012	327	88	304	69	12	33	193	34	34		6106	550
Barbel		2	2		4	5	8	11	4	7	4	47	-
Roach	9	8	8	3	18	5	6	12	8	31	5	113	470
Dace							6	34	6	16		62	11
Perch	3	4	10		12	7	4	3	14	2		59	2
Nase					2							2	8
Chub	6	7	4	1	6	3	2	5	4	2		40	20
Other species	13	8	6	1	3	1				8		40	304
No. of species	9	12	11	4	8	6	6	6	6	9	2	18	19
Total	5043	356	118	309	114	33	59	258	70	100	9	6469	1365

Results

During the late summer and fall i.e. from August to October 2003 and 2004, many fish migrated through the fishpass. The numbers were comparable to the spring spawning movements through the same fishpass in the same year (Fig. 1). Table 1 gives a summary of abundant species (bleak *Alburnus alburnus*, roach *Rutilus rutilus*, barbel *Barbus barbus*, dace *Leuciscus leuciscus*, nase *Chondrostoma nasus* and perch *Perca fluviatilis*) and their numbers that migrated in the late summer and fall together with comparison to the spring spawning migrations in both years. Other species that occurred in the fishpass during the late summer and fall in 2003 were (in descending order according to total numbers) chub *Leuciscus cephalus*, gudgeon *Gobio gobio*, ide *Leuciscus idus*, pikeperch *Sander lucioperca*, white bream *Abramis bjoerkna*, catfish *Ictalurus nebulosus*, common bream *Abramis brama* and Prussian carp *Carassius* '*gibelio*'; and in 2004 chub, ide, catfish, asp *Aspius aspius*, white bream, common bream, Prussian carp, eel *Anguilla anguilla*, trouts *Salmo trutta* morpha *fario* and *Oncorhynchus mykiss* and gudgeons *G. gobio* and *G. albipinnatus*. Fish often migrated in single species and one cohort shoals.

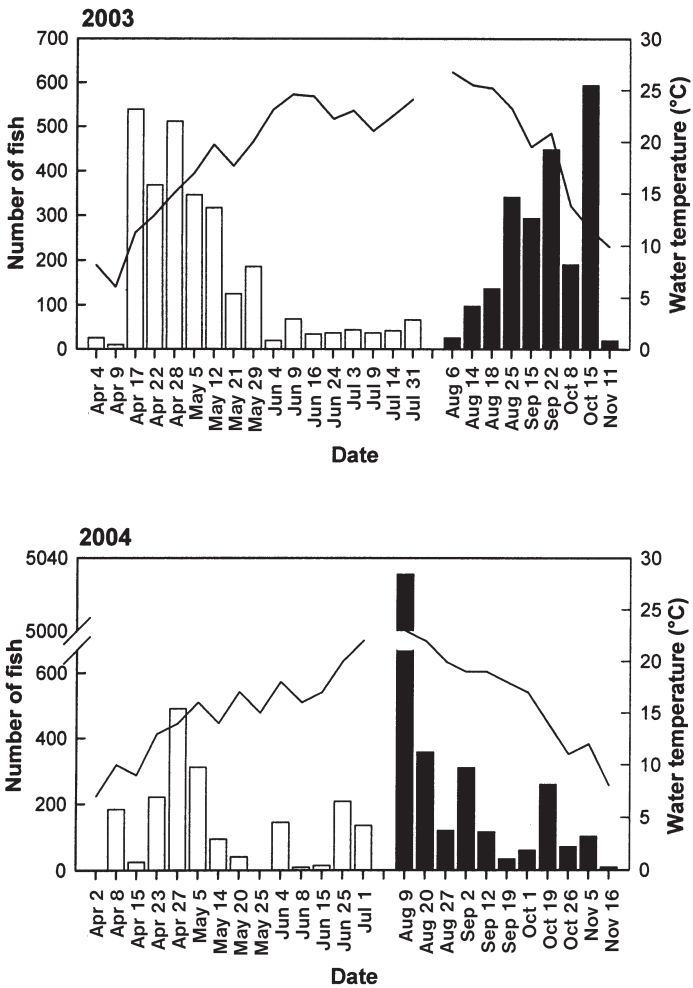

Fig. 1. Seasonal pattern of the fish migration through the studied fishpass during the spring (open bars) and during the late summer & fall (black bars) together with development of water temperature (thin line) in the year 2003 and 2004.

In both years, the fish representing the late summer and fall migrations were mostly juveniles and subadults i.e. the fish of age 0+ and 1 and 2+, respectively (e.g. roach – Fig. 2). The fish lengths differed significantly between the late summer and fall and the spring catches as it is shown in Table 2. The most pronounced differences were found in the most abundant species – bleak and roach. Significant portion of migrants were represented by 0+ fish (up to 80 mm SL) – 62% in dace and 11% of roach in 2003 and 47% in bleak in 2004.

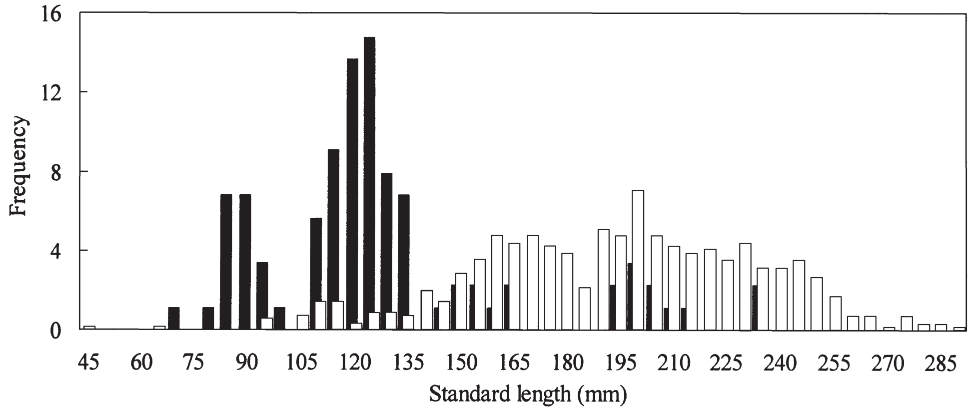

Fig. 2. Length distribution of roach from the spring (open bars) and late summer & fall migrations (black bars) in 2003. Data series are overlapping.

Table 2. Differences in fish lengths (mm) between the late summer and fall (SL fall, average) and the spring migrations (SL spring, average) tested by t-test in species with relevant numbers. Range corresponds with minimal and maximal lengths of fish from the late summer and fall migrations.

Species	Year	Range	SL fall	SL spring	t	DF	p
Roach	2003	70 – 239	130	196	26.699	970	<0.001
	2004	51 – 275	158	176	3.795	604	<0.001
Bleak	2003	35 – 142	120	128	7.190	1005	<0.001
	2004	14 – 209	116	126	9.412	991	<0.001
Barbel	2003	40 – 312	160	44 (!)			
	2004	71 – 341	222	no fish			
Dace	2003	56 – 179	93	128			
	2004	122 – 186	138	132			
Nase	2003	66 – 100	92	265			
Perch	2003	82 – 114	98	no fish			
	2004	109 – 221	160	193			
Chub	2003	123 – 324	210	283			
	2004	140 – 330	240	278			

Discussion

This study showed that fish utilize fishpasses not only during the spawning migrations but also during another part of a year. After a period of relatively low migration activity in June and July (local movements), fish started to move again in August to November in similar numbers as in the spring (Fig. 1; P r c h a l o v á et al. 2006a, 2006b). Further, fish migrating during the late summer and fall were represented mostly by immature individuals of common cyprinid species like bleak, roach and barbel (Table 2).

Information about migrations of cyprinid juveniles and about migration out of spawning time in rivers can be found only in a form of brief remarks in the literature. Our findings coincide with those of Travade et al. (1998) and Prignon et al. (1998), who described significant fall movements through French and Belgian fishpasses (for resume see Fig. 4.2 and relating text in Lucas & Baras 2001). Smaller individuals of roach were found to pursue considerable migration from September to November and migration peaks may also occur in barbel during October and in perch from September to December (Travade et al. 1998). Prignon et al. (1998) observed substantial fall migrations of roach and dace, however, individuals of roach from fall migrations were larger than during spring spawning movements.

The reason for the observed migration was most probably upstream directed searching of suitable feeding grounds in August and refuge-seeking in September and October. During the fall fish migrated often in single species and one cohort shoals. This shoaling character was described by Borcherding et al. (2002) in juvenile roach, common bream, perch and rudd *Scardinius erythrophthalmus* during diel migration between floodplain lakes and associated channels. Such organization is believed to help in better protection against predation.

This paper shows that migration of immature fish out of spawning time is not unimportant and deserves more research attention.

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