

Size and structure of a new lake minnow, *Eupallasella percunurus* (Pall.), population established through translocations

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Abstract. In July and August 2010, the Lincoln-Petersen capture-recapture method was used to assess the size and basic structure of a newly established population of the endangered in Poland cyprinid fish lake minnow, *Eupallasella percunurus* (Pall.). The population that inhabits a small (0.08 ha) peat excavation site in the village of Kowalicha near Radzymin (Mazowieckie Voivodeship, Poland) was initiated in 2004-2006 using the translocations of a total of 1530 cultivated individuals, mostly juveniles aged 0+. The total size of the *E. percunurus* population was estimated to be 600 individuals excluding aged 0+. The population size is not considered to be large in comparison with other populations inhabiting water bodies of similar surface areas. Males proved to be predominated by females – phenomenon typical of populations of this species – but at relatively high ratio of approximately 1:4. Most of females were aged 2+, whereas most of males were older (3+). These data indicate that the population remains in the early stages of development. The Lincoln-Petersen method proved useful in the studies of the size and structure of *E. percunurus* populations.

Keywords: lake minnow, population size, sex structure, length distribution, age structure

Introduction

Populations of the endangered with extinction cyprinid fish lake minnow, *Eupallasella percunurus* (Pall.), occur in five of 16 voivodeships in Poland (Wolnicki and Radtke 2009). This strictly protected species, which is of exceptionally high ecological status in Poland (Kusznierz et al. 2005), requires active protection measures. However, only Mazowieckie Voivodeship is currently involved in an active protection program for this fish that was initiated in 2002 (Wolnicki et al. 2008b, 2011). In addition to measures such as broodstock management and captive breeding, the program also includes establishing entirely new populations through translocations, and, very recently, monitoring these populations. Knowledge of the status of new populations of this species is a measure of the appropriateness methods applied to its conservation.

Up to date, six new *E. percunurus* populations were initiated in Mazowieckie Voivodeship through either single or repeated translocations between 2004 and 2011 (Wolnicki et al. 2011). The aim of the present work was to evaluate for the first time the size and structure of the oldest of these populations, which was initiated in 2004 and is located in the village of Kowalicha near Radzymin (Mazowieckie Voivodeship, Poland). This study also provided an opportunity to assess the suitability of the Lincoln-Petersen method in studies of new populations of this species. To this aim, the method was applied twice.

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Material and methods

Study area

The site in Kowalicha (N 52°30'29"; E 21°15'26") came into existence several decades ago as a result of manual peat excavation. Today, it is an isolated complex comprising one larger water body (max. 0.08 ha, max. depth 1.5 m) and three tiny peat pits, which are all surrounded by forests. The four basins can occasionally merge together, and then the water surface of the whole complex is about 0.15 ha (Wolnicki et al. 2008b). The dystrophic water is usually characterized by low pH (< 6.0) and electrolytic conductivity (< 100 $\mu\text{S cm}^{-1}$) values (Kamiński et al. 2011).

Origin of *E. percunurus* population

Before the first *E. percunurus* translocation, the water bodies in Kowalicha were inhabited exclusively by the dwarf form of Prussian carp, *Carassius gibelio* (Bloch) (Wolnicki et al. unpubl. data). In 2004-2006, three consecutive translocations of a total of 1530 young cultivated fish, mostly aged 0+, were performed (Wolnicki et al. 2008b, 2011). All the fish were introduced into the largest water body. The fish were the pooled progeny of several tens of parental individuals that descended from a large population inhabiting Krogulec Lake, a small mid forest basin located nearby (2 km). The translocations were ceased in 2007 after the translocated *E. percunurus* were found to have matured and were confirmed to be spawning successfully.

Population studies

The studies of the *E. percunurus* population in Kowalicha were performed in 2010, which was about four years after the final translocation, and comprised evaluations of population size, sex structure, and length distribution. The latter parameter was used to evaluate the age structure of the population (Bagenal and Tesch 1978). The size of the

population was estimated with the Lincoln-Petersen capture-recapture method (Young and Young 1998, Henderson 2003, Skórka et al. 2003), which is suitable for closed populations, when neither immigration nor emigration occurs. Since the population in Kowalicha inhabits an isolated complex of water bodies, and is subject only to incidental angling pressure, it can be classified as a closed population.

The first catch was on July 8, 2010, and the second (recapture) was two days later (Table 1). Both of the catches were done at the end of *E. percunurus* spawning period, when mature females, mature males, and immature individuals can be identified infallibly (Wolnicki 2004). To verify the reliability of the results obtained, a third catch (i.e., second recapture) was performed on August 5, which was shortly after the spawning period. The basic water quality parameters during the studies are presented in Table 1.

Table 1

Water quality parameters during studies of the *Eupallasella percunurus* population in Kowalicha

Date	Parameter			
	Water temperature (°C)	Oxygen saturation (%)	pH	Electrolytic conductivity ($\mu\text{S cm}^{-1}$)
July 8, 2010	21.5	51	6.47	50
July 10, 2010	19.4	47	6.57	50
August 5, 2010	19.5	30	6.19	52

All catches were performed in the largest water body with baited folding traps with two openings (25 × 25 × 40 cm; mesh 5 mm; opening diameter 60 mm) (Wolnicki et al. 2008a, 2008b). The trap exposition time was 1.5-2.5 h. During the first and the second catch, nine traps distributed identically were used. The third catch was done using six traps situated according to a different pattern. All of the traps were placed in deeper (> 0.5 m) parts of the water body at the very edge of dense patches of macrophytes with floating leaves (*Nymphaea alba*, *Potamogeton natans*).

All of the fish captured were held alive in tanks (30 dm³) provided with aeration. Measurements and other manipulations with the fish were preceded by

Table 2Number of *Eupallasella percunurus* individuals caught in Kowalicha, recapture rates, and estimated population size

Fish groups	Number of fish marked in 1 st catch (M)	2 nd catch			3 rd catch				
		Total number of fish (C)	Number of fish marked (R)	Recapture rate (%)	Number of fish in population (N)*	Total number of fish (C)	Number of fish marked (R)	Recapture rate (%)	Number of fish in population (N)*
Males	67	29	17	25.4	114 (99-135)	43	26	38.8	111 (99-126)
Females	287	205	151	52.6	390 (375-405)	217	146	50.9	427 (408-446)
Juveniles	52	29	22	42.3	69 (62-76)	31	19	36.5	85 (75-98)
Total	406	263	190	-	573 (543-583)	291	191	-	623 (595-644)

Recapture rate = $R \times M^{-1} \times 100$; *N = $M \times C \times R^{-1}$; in brackets 95% confidence limit

their anesthetization in 0.45 g dm⁻³ water solution of 2-phenoxyethanol. The fish were counted and divided into four groups: mature males, mature females, juveniles, and smallest individuals aged 0+ (larvae and/or earliest juveniles measuring 10-20 mm in total length). Due to their small size which makes marking impossible, individuals from the smallest group were only counted, but were not used to assess the size or structure of the population.

Both primary and secondary sex characteristics were considered to determine fish sex. Males were identified after gentle pressing of their belly when profuse milt was released by the point of protruding sex papilla (1st and 2nd catch) or by presence of protruding sex papilla only (3rd catch). Females were identified by the lack of a sex papilla and the presence of an enlarged, reddened sex opening. In some cases (1st and 2nd catch), females were identified when eggs were released spontaneously. Fish longer than 40 mm total length and exhibiting no distinct male or female morphological features were classified as juveniles aged at least 1+. All males, females, and juveniles aged 1+ or older caught in the first catch were measured (total length to the nearest 0.1 mm) and marked by clipping the ends (2-3 mm long) of their right pelvic fin. This marking method is entirely safe for the fish, and although fin regeneration occurs in about four weeks, the ends remain colorless so these fish are easily distinguished for a much longer period. All of the fish caught in both recaptures were counted; fish aged 1+ or older were classified as marked or unmarked individuals, and their

sex was determined. After all the manipulations had been done and the fish had recovered, they were released at the same site where they had been caught.

Results

The fish trapped during three catches belonged to two cyprinid species: *E. percunurus* and *C. gibelio*, with the distinct predominance of the former. As to the latter, a total 69 individuals were counted. Moreover, altogether 190 *E. percunurus* at the age of 0+ were caught, most of them (110) were found in the first catch.

In the first catch, from five to 114 *E. percunurus* individuals older than 0+ were recorded per trap. In total, 406 individuals of this species were caught and marked, and comprised 67 males, 287 females, and 52 juveniles (Table 2). In the second catch, 263 *E. percunurus* individuals were noted, and 190 of these fish were marked. The recapture rates were 25.4, 52.6, and 42.3%, for males, females, and juveniles, respectively. In the third catch, 291 *E. percunurus* individuals (191 marked) were recorded. The respective recapture rates were 38.8, 50.9, and 36.5%. Based on these data, the total size of the *E. percunurus* population was estimated to be 573 (1st and 2nd catch) or 623 (1st and 3rd catch) individuals aged at least 1+.

Female *E. percunurus* dominated over males in all of the catches performed, and in the estimated size of the population as a whole (Table 3).

Table 3
Sex structure of the *Eupallasella percunurus* population in Kowalicha

Calculation basis	Number of mature fish		Sex ratio
	Males	Females	
Number of fish marked in 1 st catch	67	287	1 : 4.3
Pooled number of fish marked in 1 st catch, but not in 2 nd catch	79	341	1 : 4.3
Pooled number of fish marked in 1 st catch, but not in 3 rd catch	84	358	1 : 4.3
Total number of fish from 2 nd catch	114	390	1 : 3.4
Total number of fish from 3 rd catch	111	427	1 : 3.8

According to the calculation method applied, the sex ratio among the mature fish (males-to-females) ranged from 1:3.4 to 1:4.3.

The total lengths of juvenile, male, and female fish marked in the first catch was 51.2 ± 5.9 , 65.4 ± 4.0 , and 59.5 ± 5.9 mm (mean \pm SD), respectively (significant differences, $P \leq 0.05$; ANOVA with Tukey's test). The distribution of fish total length for the distinguished sex groups is presented in Figure 1. Females aged 2+ dominated the population. Males were dominated by individuals aged 3+. Some of the largest females likely belonged to the 4+ age class.

Discussion

Scientific data on the size and structure of *E. percunurus* populations are exceptionally scarce. The only information regarding this issue originates from studies performed in Zielonka near Warsaw, Poland in 2008 (Wolnicki et al. 2008a) and 2010 (Wolnicki et al. unpubl. data). This *E. percunurus* population has been in existence for probably about 40 years. In this particular case, the total number of adult males, adult females, and juveniles older than 0+ was estimated at 2500 individuals in 2008 and at 1300 in 2010. Taking into account the fact that the water bodies in Zielonka and Kowalicha are of similar water surface area (Wolnicki et al. 2008b), the current size of the *E. percunurus* population inhabiting the latter reservoir (approximately 600 individuals; Table 2) is low.

There were considerable differences between the aforementioned populations as concerns the sex ratio among adult fish. The fact that female

E. percunurus generally dominate over males is known from previous observations (Kaj 1953, Brusynina 1974, Kuszniierz unpubl. data) and population studies (Wolnicki et al. 2008a and unpubl. data), which have all focused on populations that have existed for long periods estimated at several decades. However, the male to female ratio of 1:3.4-4.3 noted in the current study (Table 3) was considerably lower than that in populations that have existed for much longer and in which it is about 1:2. Obviously, the high share of females to males among the sexually mature individuals in Kowalicha should be regarded as beneficial for this young population; the same applies to the abundant presence of individuals aged 0+.

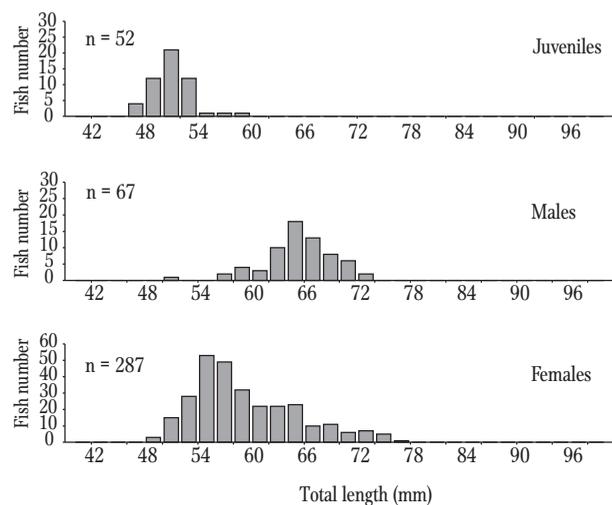


Figure 1. Total length distribution of the *Eupallasella percunurus* population in Kowalicha.

The unusually low male to female ratio recorded for the population in Kowalicha could be regarded as a methodological error resulting from different sex-related fish behavior in the spawning period. This hypothesis was formulated by Wolnicki et al. (2008a). In the mid-spawning period, they noted considerable differences between the recapture rates for *E. percunurus* males (7.1%) and females (31.3%) from a population occurring in Zielonka. These authors conjectured that during this period female fish might be more attracted by baited traps and might swim into them more willingly than do males and juveniles. Clearly, this could distort assessments of both population size and sex structure. However, sampling in the case of the population in Kowalicha was conducted late in the spawning period or even after its completion (3rd catch). In all cases, three sex groups were recaptured at high rates but, again, the recapture rates for females were higher than for the two other groups. There was also a distinct difference between the recapture rates for males captured at the second and the third catch (25.4 and 38.8%, respectively; Table 2), but the difference did not influence the estimated number of male individuals in the population. Although all these data do not allow reject the hypothesis formulated by Wolnicki et al. (2008a), it should be remembered that the only possibility to reliably assess the sex structure of *E. percunurus* populations is to capture fish during spawning or very shortly thereafter since only then the morphological differences between the sexes are evident (Wolnicki 2004).

Some differences were also noted between the older *E. percunurus* population in Zielonka and that in Kowalicha as concerns fish size and age structure. In the former, the largest individuals were females with the strong domination of fish aged 2+ (Wolnicki et al. 2008a); in the latter, males at the same age with a very low share of males belonging to 1+ and 2+ age classes (Figure 1). Likewise, the representation of mature females in age class 1+ was very low. On the other hand, some of the largest females in Kowalicha might have belonged to the 4+ age class. Moreover, the mean size of juveniles and females in this population was greater than in Zielonka. It should be

stressed that in *E. percunurus* populations the early maturation of both sexes at relatively small individual sizes and the short life span of the fish of up to 3+ is considered a reliable indicator of overcrowded populations inhabiting small, shallow water bodies (e.g., Movchan 1976, Tandon 1979, Kuszniez unpubl. data). Thus, it seems obvious that the population initiated in Kowalicha, with its relatively low estimated number of fish, the strong predominance of females, and the high number of individuals aged 0+ found in traps, remains in the early stages of development and is far from being overcrowded. The population also appears to have good prospects for its further development thanks to relatively high intrapopulation genetic variability (Kaczmarczyk et al. 2011), water conditions that are superior to those in previous years (Kamiński et al. 2011), and little competition from the cohabiting fish species *C. gibelio*.

Despite doubts concerning the possible sex selectivity of the traps used in the present studies, the reliability of the estimations of the size and structure of *E. percunurus* population using the Lincoln-Petersen method seems satisfactory. Generally, the high recapture rates for the three sex groups distinguished and the comparable results of the second and the third catch justify this conclusion.

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References

- Bagenal T.B., Tesch F.W. 1978 – Age and growth – In: Methods for the assessment of fish production in fresh waters (Ed.) T.B Bagenal. Blackwell Scientific Publications, Oxford: 101-136.
- Brusynina I.N. 1974 – Growth and size structure of lake minnow population – Acad. Sci. SSSR, Ural Research Centre, Tomsk: 146-149 (in Russian).
- Henderson P.A. 2003 – Practical methods in ecology – Blackwell Science Ltd, 163 pp.

- Kaczmarczyk D., Żuchowska E. 2011 – Genetic diversity of two lake minnow, *Eupallasella percunurus* (Pall.), populations based on microsatellite DNA polymorphism – Arch. Pol. Fish. 19: 145-151.
- Kaj J. 1953 – Distribution and breed variability of fish form species *Phoxinus percunurus* Pall. in Poland – Pol. Arch. Hydrobiol. 1: 49-78.
- Kamiński R., Wolnicki J., Sikorska J. 2011 – Physical and chemical water properties in water bodies inhabited by the endangered lake minnow, *Eupallasella percunurus* (Pall.), in central Poland – Arch. Pol. Fish. 19: 153-159.
- Kusznierz J., Wolnicki J., Radtke G., 2005 – Swamp-minnow, *Eupallasella perenurus* (Pallas), – status and perspectives for protection – Chrońmy Przyr. Ojcz. 61: 70-78 (in Polish).
- Mooching Y.V. 1976 – Morphoecological characteristics of lake minnow *Phoxinus phoxinus* (Pallas) – (Pisces, Cyprinidae) in some water bodies in Ukraine – Zoological Museum, Academy of Sciences of the USSR 36: 54-62 (in Russian).
- Skórka P., Nowicki P., Witek M. 2003 – Population size estimation with capture-mark-recapture methods – standards and new solutions – Wiad. Ekol. 49: 205-220 (in Polish).
- Tandon K.K. 1979 – Age and growth of *Phoxinus percunurus* (Pallas, 1811) from Poland – Zool. Pol. 27: 187-194.
- Wolnicki J. 2004 – The lake minnow *Eupallasella perenurus* (Pallas, 1814) – In: Animals species (excluding birds). Guide to habitats and species protection. Natura 2000 (Eds) P. Adamski, R. Bartel, A. Bereszyński, A. Kapel, Z. Witkowski, Warszawa, T. 6: 229-233 (in Polish).
- Wolnicki J., Radtke G. 2009 – Assessment of the present state of the occurrence, threats and protection of lake minnow *Eupallasella percunurus* (Pallas, 1814) in Poland – Chrońmy Przyr. Ojcz. 5: 329-340 (in Polish).
- Wolnicki J., Kamiński R., Sikorska J., Kusznierz J. 2008a – Assessment of the size and structure of lake minnow *Eupallasella percunurus* (Pallas, 1814) population inhabiting small water body in Central Poland – Teka Kom. Ochr. Kształt. Środ. Przyr. – OL PAN 5: 181-189.
- Wolnicki J., Sikorska J., Kamiński R. 2008b – Occurrence and conservation of the endangered cyprinid fish species, lake minnow *Eupallasella percunurus* (Pallas, 1814), in the Mazowieckie Voivodeship in Poland – Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN 5: 190-198.
- Wolnicki J., Kamiński R., Sikorska J. 2011 – Occurrence, threats and active protection of the lake minnow, *Eupallasella percunurus* (Pall.), in Mazowieckie Voivodeship in Poland – Arch. Pol. Fish. 19: 209-216.
- Young L.J., Young J.H. 1998 – Statistical ecology: a population perspective – Kluwer Academic Publishers, 565 p.

Streszczenie

Wielkość i struktura nowej populacji strzebli błotnej *Eupallasella percunurus* (Pall.) powstałej w wyniku translokacji

Stanowisko strzebli błotnej z mazowieckiej miejscowości Kowalicha (52° 30' 29" N; 21° 15' 26" E) jest jednym z sześciu w kraju, jakie powstały w wyniku translokacji hodowlanych osobników tej ryby. W latach 2004-2006 przeniesiono ich tam łącznie 1530, w tym 1100 młodocianych w wieku 0+. Materiał ten był potomstwem kilkudziesięciu dzikich osobników, pochodzących z populacji zamieszkującej pobliski zbiornik wodny Krogulec. W lipcu i sierpniu 2010 r. przeprowadzono pierwsze badania stanu nowej populacji strzebli błotnej. Zastosowano w tym celu metodę Lincolna-Petersena, polegającą na połowie ryb w pułapki z przynętą, poznaowaniu ryb przez odcięcie fragmentu płetwy brzusznej, uwolnieniu ich i powtórny połowie. Z badań wyłączono osobniki w wieku 0+. W wyniku pierwszego połowu poznakowano łącznie 406 ryb, w tym 287 dojrzałych płciowo samic, 67 ciekających samców oraz 52 osobniki młodociane w wieku co najmniej 1+. W drugim połowie, przeprowadzonym po dwóch dniach, stwierdzono 263 ryby, z których 190 było

poznakowane. Na tej podstawie liczebność populacji strzebli błotnej oszacowano na 573 osobniki, łącznie samic, samców i młodocianych w wieku co najmniej 1+. Dla zweryfikowania uzyskanych wyników, po upływie miesiąca przeprowadzono trzeci połów ryb. Wielkość populacji oszacowano tym razem na 623 osobniki z przeważającym udziałem samic. W zależności od metody obliczeń stosunek płci (samce : samice) w badanej populacji wahał się od 1:3,4 do 1:4,3, podczas gdy w populacjach mających długi rodowód przewaga samic jest znacznie mniejsza. W drugim i trzecim połowie odsetek samców poznakowanych był niższy (odpowiednio 25,4 i 38,8%) niż poznakowanych samic (odpowiednio 52,4 i 50,9%). W populacji dominowały samice w trzecim, a samce w czwartym roku życia. Wyniki przeprowadzonych badań sugerują, że badana populacja jeszcze nie ukształtowała się pod względem liczebności, ani struktury wiekowej i płciowej. Metoda Lincolna-Petersena dowiodła swojej przydatności do monitorowania stanu populacji strzebli błotnej.