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# ASSESSMENT OF THE SIZE AND STRUCTURE OF LAKE MINNOW *Eupallasella percnurus* (Pallas, 1814) POPULATION INHABITING A SMALL WATER BODY IN CENTRAL POLAND

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**Summary.** The present study was the first attempt at evaluating the size and sex structure of the population of lake minnow *Eupallasella percnurus*, a critically endangered in Poland cyprinid fish species, by means of the capture-recapture Lincoln-Petersen method. The study area was a small (approx. 0.1 ha) man-made fire reservoir located near town of Zielonka in the Mazowieckie Voivodeship. To assess the age structure of the population, frequency distribution of fish total length was used. The total size of the population was estimated at 2000–2500 individuals, including males, females and juveniles aged 1+ or older. Male-to-female ratio in mature individuals was found to be 1 : 2. Young fish belonging to 1+ and 2+ age classes dominated in the population, which may indicate that it is overcrowded. The capture-recapture method appears to be useful in the spawning period for the evaluation of the size and structure of *E. percnurus* population, provided that fish behaviour – considerably influencing fish recapture rates – is taken into consideration.

**Key words:** lake minnow, population size, sex structure, length distribution, age structure

## INTRODUCTION

The lake minnow *Eupallasella percnurus* is a tiny cyprinid fish of vast geographical range in the northern hemisphere, extending from the territory of Poland in the west to the Pacific Ocean in the east. This species belongs to the most endangered representatives of the Polish freshwater ichthyofauna [Witkowski 1999]. It is law-protected and included in the Polish Red Data Book of Animals [Kusznierz 2001]. This fish is also a priority vertebrate species in the European Ecological Natura 2000 Network [Kusznierz *et al*. 2005]. The Polish populations inhabit small water bodies, at present man-made rather than natural ones, most often strongly shallowed remnants of

old peat excavations. Such water bodies are highly liable to total destruction resulting particularly from water deficits [Wolnicki *et al*. 2008a, b].

Conservation of *E. percnurus* requires protection of both its habitats and the most valuable populations within the Special Protection Areas (SPAs), included in the Natura 2000 Network [Kusznierz *et al*. 2005]. To this end, reliable data on the condition of the particular populations are indispensable. However, because of the almost complete lack of related scientific studies in the recent past and presently, knowledge of all the Polish populations of this species remains far out of date and superficial.

The present work was devoted to assessing the size and basic structure of *E. percnurus* population inhabiting a small water body situated in Central Poland. This *E. percnurus* station will presumably be involved in the Natura 2000 Network.

## STUDY AREA

The study area was a midforest isolated water body (52°17'46" N, 21°08'29" E), named Zielonka, located at a close distance from the town of Zielonka in the Mazowieckie Voivodeship in Central Poland. This water body came into existence in the 1960s as a fire reservoir, but *E. percnurus* was found to occur there only in the spring of 2006 [Wolnicki *et al*. 2006a, 2008b].

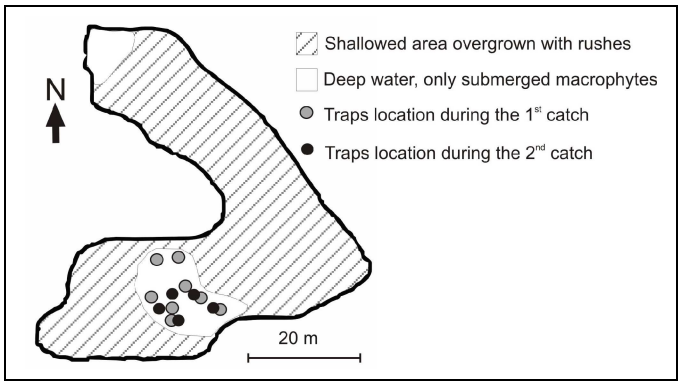


Fig. 1. Location of traps used for the 1st and the 2nd catch of *E. percnurus* in Zielonka

The water surface of 0.07–0.12 ha and the maximum water depth of 0.5–1.5 m, dependent mainly on precipitation, proved to be highly variable both throughout a year and from year to year [Wolnicki *et al*. 2008b and unpubl. data]. By today about 90% of the bottom of the water body has become extremely shallowed. As a consequence, this part of the bottom is densely overgrown with the common reed *Phragmites australis* (Fig. 1). Larger water depth has been retained in two small parts of the water body. Bigger and deeper one was

used as a catching area.

## MATERIAL AND METHODS

In the present study, the following parameters of *E. percnurus* population were assessed: size, sex structure and fish length distribution. The last parameter was then used to evaluate the age structure of the population [Bagenal and Tesch 1978]. The fish abundance was estimated using the capture-recapture (mark-recapture) Lincoln-Petersen method [Skórka *et al*. 2003]. The method is considered reliable for so-called closed populations, in which neither immigration nor emigration occurs [Seber 1982, Williams *et al*. 2002]. The station in Zielonka is an entirely isolated water body and is not subject to any stronger angling pressure, therefore *E. percnurus* living there perfectly complied with the precondition of being an isolated population.

The 1st fish catch was conducted on June 5, 2008, whereas the 2nd one (fish recapture) took place 4 days later, i.e. in the middle of *E. percnurus* spawning period [Wolnicki 2005]. Water temperature was then about 16°C. Fishing was performed with the use of specialized folding traps with two openings ($25 \times 25 \times 40$ cm; mesh 5 mm; opening diameter 60 mm), with a piece of bread used as bait [Wolnicki *et al*. 2006b, 2007]. Traps were placed in the deepest part of the water body, free from emerged macrophytes (Fig. 1), with the depth while fish catching of 0.5–0.9 m. Eight and five traps were used in the 1st and 2nd catch, respectively, and the exposition time was 1–2 hours.

Prior to any manipulation, captured fish were anaesthetized in water solution of 2-phenoxyethanol at 0.45 g $dm^{-3}$ [Kamiński *et al*. 2004]. Three fish groups, i.e. mature males, mature females and juvenile individuals of indeterminable sex were distinguished. Larval *E. percnurus* (age 0+) were not found among fish trapped. To determine fish sex, both their primary and secondary sexual characteristics were taken into account. Males were identified after gentle pressing their belly when profuse milt was released by the point of protruding sex papilla. Moreover, indistinct spawning rash was present on male head, and their fins were coloured bright orange. Female fish had more or less rounded belly with no sex papilla, and their sexual opening was enlarged and reddened. Some females released eggs spontaneously. Individuals showing no distinct male or female morphological features were considered as juveniles. All males, females and juveniles, captured in the 1st catch, were counted. Before being set free, all of them were marked by clipping the end part (2–3 mm long) of their right pelvic fin. From among them, fish belonging to three distinguished groups were randomly taken to measure their total length to the nearest 0.1 mm (total n = 205). In the 2nd catch, the number of marked and not marked males, females and juveniles was determined.

## RESULTS

All fish trapped were *E. percnurus* individuals. In the 1st catch, vast majority of fish were those recorded in traps placed in the southern zone of the catching area. A total of 621 fish were captured then, among them 184 mature males and 288 mature females (Tab. 1). In the 2nd catch, 367 fish were captured, including 75 males and 227 females; marked were 13 males and 90 females. The recapture rates for both these fish groups equalled to 7.1 and 31.3%, respectively. The juvenile individuals were recaptured at the rate of 9.4%. Using separate data related to all fish groups, the total number of *E. percnurus* individuals in the population was estimated at 2480 fish. This figure included 1062 mature male individuals and 726 mature females.

Table 1. Number of *E. percnurus* individuals captured in Zielonka, recapture rates and estimated size of the population

| Fish groups | Number of marked fish (M) | Number of fish in the 2nd catch | | Recapture rate* (%) | Number of fish in a population (N)** |
|---|---|---|---|---|---|
| | | Total (C) | Marked (R) | | |
| Mature males | 184 | 75 | 13 | 7.1 | 1062 (857–1393) |
| Mature females | 288 | 227 | 90 | 31.3 | 726 (674–787) |
| Juveniles | 149 | 65 | 14 | 9.4 | 692 (565–892) |
| Total | 621 | 367 | 117 | – | 2480 (2097–3072) |

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

The sex structure of *E. percnurus* population is shown in Table 2. Calculations were done for all captured individuals or for mature fish only. The share of male and female fish in the whole population was estimated at 26.2 and 52.1%, respectively. When juvenile fish were excluded from the calculations, the respective figures equalled 33.5 and 66.5%, respectively. In both cases male-to-female ratio was nearly 1 : 2.

Table 2. Sex structure of *E. percnurus* population in Zielonka

| Fish groups | Juveniles included (%) | Juveniles excluded (%) |
|---|---|---|
| Mature males | 26.2 | 33.5 |
| Mature females | 52.1 | 66.5 |
| Juveniles | 21.7 | – |

Percentages computed using the pooled direct results of the 1st and 2nd catch.

The mean total length of juvenile, male and female *E. percnurus* individuals was 48.2, 62.0 and 70.4 mm, respectively, and all these values differed significantly ($P \leq 0.05$, Student's t-test). The fish total length distribution in the population is illustrated, separately for juveniles, males and females, in Figure 2.

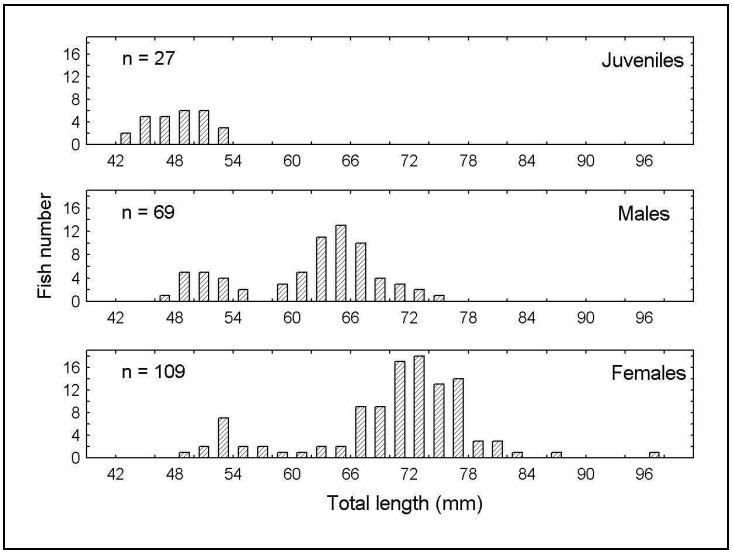


Fig. 2. Total length distribution in *E. percnurus* population in Zielonka

The population was dominated by individuals belonging to two age classes: 1+ and 2+, and the few largest females probably represented the 3+ age class. Among fish aged 1+, numerous males and some females attained sexual maturity.

## DISCUSSION

The present study is the only known attempt to assess – using capture-recapture Lincoln-Petersen method – the size and structure of *E. percnurus* population in Poland. It should be stressed that no results of similar studies with this fish species and the same catching method can be found in any published sources of information. The fundamental question then arises about the appropriateness of the method used in the present work to evaluate *E. percnurus* populations.

It can be seen from our results that in the total number of fish, captured in the 1st and 2nd catch, a substantial difference took place (621 *v.* 367 individuals, respectively; Tab. 1). Furthermore, considerable differences were found between both these catches as concerns the percentage share of individuals belonging to all distinguished fish groups, i.e. mature males, mature females and juveniles. For example, 288 females captured in the 1st catch constitute 46.4% of the total number of fish caught then. For the 2nd catch, the respective value is much higher – 61.9%. Also noteworthy is the fact

that considerable differences were recorded concerning the recapture rates for all fish groups, ranging from 31.3% for females to only 7.1% for males.

As to the differences in the total number of the captured fish, one of possible explanations of this phenomenon could be the fact that different number of traps was used in the 1st and 2nd catch (8 *v.* 5, respectively). Although, in the first case, vast majority of fish were those captured closely to the southern shore of the water body (that is why lower number of traps was used in the 2nd catch), it seems likely that applying 8 traps also in the 2nd catch would have then resulted in higher total number of the captured fish and higher recapture rates of marked individuals.

All these explanations, however, do not elucidate the reasons for the remaining two phenomena mentioned above. It should be emphasized that the present study was carried out in *E. percnurus* spawning period. This was because distinct morphological differences, existing only at that time, made it possible to infallibly distinguish males, females and older juveniles [Wolnicki 2005]. Therefore, it can be assumed that the fishing results, obtained in the present study, remained under the influence of fish spawning behaviour, being not necessarily identical for both catches as well as for all fish groups. Hence, females might have been attracted by the bait stronger and swam into traps more eagerly as compared to male or juvenile individuals. Consequently, female fish distinctly dominated in both catches and attained relatively high recapture rate. In contrast, recorded for both males and juveniles, considerably lower recapture rates may be not representative for the actual share of these groups in *E. percnurus* population as a whole.

It seems difficult at present to decide about the real reasons for the aforementioned findings. However, it should be mentioned here that in very similar field study of *E. percnurus* population, occurring in Kowalicha (another small water body in the Mazowieckie Voivideship), the recapture rates, recorded for male, female and juvenile fish, were considerably higher and very uniform, ranging just from 40 to 50% [Wolnicki *et al*. 2008a and unpubl. data].

If then the recapture rates recorded for males and juveniles in Zielonka are really not representative, the use of separate data for the three fish groups can lead to overestimation of the actual population size. On the other hand, the use of pooled data may cause its underestimation [e.g. Beukema and de Vos 1974]. As a matter of fact, the latter approach is commonly practised in studies of fish populations [Beukema and de Vos 1974, Piironen and Holopainen 1988, Brönmark *et al.* 1995]. In the case of the population from Zielonka, the recalculated figure concerning the total fish number – based on the pooled data from Table 1 – would equal to 1948 individuals (95% confidence limit of 1819–2096 individuals).

Taking into account all the doubts mentioned above, the male-to-female ratio for the population under study can be estimated to be 1 : 2 (Tab. 2). This fact should not be considered surprising. More or less pronounced domination of adult female individuals over adult males in *E. percnurus* populations, both in the Siberian and Polish water bodies, is well documented [e.g. Kaj 1953, Brusynina 1974, Kusznierz unpubl.

data]. It is interesting that this regularity was proven with the use of different fishing methods, including angling.

The distribution of *E. percnurus* total length indicates clearly that the discussed population consisted of young individuals, mostly at the age of 1+ or 2+, whereas only the few largest females might belong to the 3+ class (Fig. 2). Of importance is the fact that some of the smallest fish, especially males, proved to reach sexual maturity. Both lack of age classes over 3+ and early maturation of *E. percnurus* individuals are good indicators of overcrowded populations, inhabiting very small and shallow water bodies [Zukov 1965, Movchan 1976, Tandon 1979, Movchan and Smirnov 1981, Kusznierz unpubl data].

## CONCLUSION

As evidenced by the results of the present work, the capture-recapture Lincoln-Petersen method, with the use of specialized traps, can be successfully applied to evaluate the size and basic structure of *E. percnurus* populations inhabiting small water bodies. However, it should be taken into consideration that in the spawning period the results obtained for different groups of individuals (mature males, mature females, immature individuals) may not be representative due to different fish behaviour.

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## OCENA WIELKOŚCI I STRUKTURY POPULACJI STRZEBLI BŁOTNEJ *Eupallasella percnurus* (Pallas, 1814) ZAMIESZKUJĄCEJ MAŁY ZBIORNIK WODNY W ŚRODKOWEJ POLSCE

**Streszczenie.** Niniejsza praca jest pierwszą próbą określenia liczebności oraz struktury krajowej populacji strzebli błotnej *Eupallasella percnurus* z zastosowaniem metody znakowania i połowu Lincolna-Petersena. Przedmiotem badań była populacja z przeciwpożarowego zbiornika wodnego (52°17’46” N, 21°08’29” E), znajdującego się koło miasta Zielonka. W czerwcu 2008 r. za pomocą pułapek z przynętą złowiono łącznie 621 osobników strzebli błotnej. Oznaczono płeć złowionych ryb lub – w przypadku niemożności jej ustalenia – zakwalifikowano do grupy osobników młodocianych. Wszyst-

kie ryby oznakowano przez obcięcie końcowego fragmentu (2–3 mm) prawej płetwy brzusznej. U losowo wybranych z każdej grupy osobników (łącznie n = 205) zmierzono długość całkowitą, a następnie wszystkie ryby uwolniono do macierzystego zbiornika. Po czterech dniach przeprowadzono ponowny połów. Tym razem złowiono 367 osobników, w tym 117 znakowanych. W drugim połowie udział osobników znakowanych wynosił od 31,3 (samice) do 7,1% (samce). Na podstawie danych na temat liczby osobników znakowanych wykazano, że liczebność populacji obliczona metodą standardową (tj. dla wszystkich ryb łącznie) była mniejsza (n = 1948) niż liczebność obliczona przez zsumowanie liczebności wyróżnionych grup ryb (n = 2480). Różnica ta wskazuje na różne prawdopodobieństwo złowienia osobników z poszczególnych grup, co może mieć podłoże behawioralne, wynikające z trwającego tarła. W takim przypadku niski procent złowionych znakowanych samców i osobników młodocianych mógłby oznaczać niepełną reprezentatywność tych danych. Użycie do oszacowania całkowitej liczebności populacji danych dla wszystkich grup ryb oddzielnie może prowadzić do jej przeszacowania, a użycie tych danych łącznie – do niedoszacowania. Stosunek liczebności dojrzałych samców i samic w populacji oszacowano na podstawie bezpośrednich wyników obu połowów na 1 : 2. Analiza struktury długości całkowitej złowionych ryb wykazała, że w populacji dominują osobniki młode w wieku 1+ oraz 2+, z których część, głównie samce, osiągnęła dojrzałość płciową. Taka struktura wiekowa jest charakterystyczna dla przegęszczonych populacji strzebli błotnej, bytujących w bardzo małych i płytkich zbiornikach wodnych.

**Słowa kluczowe:** strzebla błotna, liczebność populacji, struktura płciowa, rozkład długości, struktura wiekowa

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