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Short communications

ESTIMATED POPULATION ABUNDANCE OF CATCHABLE SIGNAL CRAYFISH (*PACIFASTACUS LENIUSCULUS* (DANA)) AND SPINY-CHEEK CRAYFISH (*ORCONECTES LIMOSUS* (RAF.)) IN LAKE POBŁĘDZIE (NORTHEASTERN POLAND)

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ABSTRACT. In 2004, monitoring catches were performed on signal crayfish, *Pacifastacus leniusculus* (Dana) and spiny-cheek crayfish, *Orconectes limosus* (Raf.), in order to estimate the abundance of the catchable populations in Lake Pobłędzie (northeastern Poland). Catches were performed using 58 Evo traps along a part of lake with an area of 1.65 ha. In catches conducted on September 6 and 7, a total of 479 specimens of signal crayfish and 29 spiny-cheek crayfish were caught, marked, and released. After twelve days, repeat catches were conducted during which 476 specimens of signal crayfish, including 66 marked specimens, and 36 specimens of spiny-cheek, including 5 marked specimens, were caught. The average total length of the caught signal crayfish was 11.7 ± 1.06 cm (7.6-15.0 cm), while that of the spiny-cheek species was 9.3 ± 0.65 cm (7.5-10.7 cm). The average catchable population abundance per unit of studied surface area was calculated at 2094 specimens ha^{-1} for signal crayfish and 127 specimens ha^{-1} for spiny-cheek crayfish. Taking into consideration that this method underestimates the population abundance of crayfish from the lower size classes, it is estimated that the actual catchable population abundance in Lake Pobłędzie might be higher by about 25%.

Key words: SIGNAL CRAYFISH (*PACIFASTACUS LENIUSCULUS*), SPINY-CHEEK CRAYFISH (*ORCONECTES LIMOSUS*), TRAPPING, RECAPTURE

The surface area of Lake Pobłędzie (northeastern Poland) is 57.6 ha. Its maximum depth is 15.4 m at an average depth of 5.9 m. The area suitable for crayfish habitation in the summer season is limited to the 5 m isobath and comprises about 13.5 ha. In summer, disadvantageous oxygen conditions prevail below 5 m (Krzywosz and Krzywosz 2002). Until 1988, the lake was inhabited by an abundant population of noble crayfish, *Astacus astacus* (L.), which was killed off by poisoning with a pesticide agent that had been applied aerially

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in the immediate vicinity of the lake (Białokoz, unpublished data). The signal crayfish, *Pacifastacus leniusculus* (Dana), was introduced into the lake in 1992. The spiny-cheek crayfish, *Orconectes limosus* (Raf.), has also occurred in the lake since 1999 (Stabiński, unpublished data).

The aim of the work was to determine the abundance of the catchable population of crayfish per unit area in the lake. The population size of crayfish per unit area of the lake is an important index that characterizes the crayfish themselves as well as the habitat they occupy. In natural water bodies, it is virtually impossible to catch and count every specimen, which is why marking and recapture methods are applied. The proportions between the number of marked and unmarked specimens recaptured provide information regarding the abundance of the catchable population caught in the area of the lake where trapping is possible according to the following formula by Petersen (Ricker 1975): $N = M \times C \times R^{-1}$, where: N – sought abundance of the population (specimens); M – number of crayfish marked (specimens); C – total number of crayfish captured (specimens); R – number of marked crayfish recaptured (specimens).

Due to periodic molting when the crayfish shed their entire carapace, permanently marking them presents a range of problems. Marking by branding or clipping the carapace (Abrahamsson 1965, Tsukerzis 1959) take a heavy toll on the crayfish, and, although these types of marks remain after molting, they may cause increased mortality as well as influence behavioral and reaction differences between marked and unmarked crayfish. Marking crayfish by attaching an external marker where the cephalothorax meets with the first carapace segment is similarly problematic (Kossakowski 1962). It is recommended that marking and recapture are conducted within a short period of time, under similar environmental conditions, and during similar activity levels of the studied population. Conducting these activities in the period between molting allowed applying a non-invasive marking method with quick drying paint on the exterior of the carapace. This allowed marking to be done immediately at the site where the trap was retrieved and also allowed the caught crayfish to be returned immediately to the water. Thanks to this, the behavior and spatial distribution of the crayfish differed only slightly from that prior to capture.

The site chosen for the study was a 600 m segment of the lake littoral from the shoreline to the 5 m isobath at approximately 20 to 35 m from the shore. During the catches in September 2004, depths below 5 m were essentially inaccessible to crayfish due to substantial oxygen deficits (> 3 mg O_2 l^{-1}). The surface area of this fragment of littoral was approximately 1.65 ha.

The catches were made with 58 Evo traps manufactured in Sweden that are used frequently in European waters. During the first catches for marking the crayfish, which were conducted for two nights on September 6-7 and 7-8, 2004, a total of 479 specimens of signal crayfish and 29 specimens of spiny-cheek crayfish were caught. During the second night of catches, some of the crayfish caught had been marked on the previous night (Table 1).

TABLE 1

Marking and recapture of crayfish in Lake Pobłędzie in 2004 in an area of 1.65 ha

	Marking crayfish			Recapture crayfish	
Species	6/7 September	7/8 September	Total	21-23 September	Abundance according to the Petersen method
Signal crayfish (specimens)	315	164+(19)	479	410+(66)	3455
Spiny-cheek crayfish (specimens)	14	15+(1)	29	31+(5)	209

( ) – number of marked crayfish in catches

The abundance of crayfish calculated based on the numbers of marked and recaptured specimens indicates that the catchable population of signal crayfish is 3455 specimens (2094 specimens ha^{-1}) and that of spiny-cheek crayfish is 209 specimens (127 specimens ha^{-1}) (Table 1). According to Edsman and Söderbäck (1999), this method for calculating population abundance is applicable with crayfish measuring above 6.0 cm in body length, while according to Abrahamsson (1966), it can be used with crayfish above 7.5 cm. Holdich et al. (1999) and Westman et al. (1999) maintain that in some conditions this method can be applied to crayfish longer than 4.0 cm. Kozák (2001) who used Evo traps to catch signal crayfish, caught specimens longer than 8.0 cm. In the current study, the average length of signal crayfish in the catches, which were also conducted with Evo traps, was 11.7±1.1 cm (7.6-15.0 cm). The decided majority of the specimens from the catchable population (96.7%) was longer than 10.0 cm (Table 2).

The frequency analysis of the individual length classes of the signal crayfish caught in Lake Pobłędzie indicates that the contribution of specimens measuring up to about 11.0 cm is most likely lower than the actual length class distribution (Table 2). This may be connected with the observation that trap catches were dominated by larger specimens, due to competition for food (bait) to which larger specimens had decidedly easier access. This likely influences certain underestimations of the catchable population size when the Petersen method is applied (Ricker 1975). This problem was identified in the works of Brown and Brewis (1979) and Kozák (2001), among others, and Kozák tested this in a pond with a signal crayfish population. First Evo traps were used and then the pond was drained and the entire population was counted, which confirmed that the underestimation of the crayfish exceeding 8 cm was 25.6%.

TABLE 2

Length distribution of crayfish recaptured in Lake Pobłędzie in 2004

Species		Length class (cm) 7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	Total	Body length (cm) Average	SD	Range
Signal crayfish	(spec.)	1	1	9	96	175	125	60	8	1	476	11.7	1.06	7.6-15.0
	(%)	0.2	0.2	1.9	20.2	36.8	26.3	12.6	1.7	0.2	100.0	-	-	-
Spiny-cheek crayfish	(spec.)	1	9	22	4	0	0	0	0	0	36	9.3	0.65	7.5-10.7
	(%)	2.8	25.0	61.1	11.1	0.0	0.0	0.0	0.0	0.	100.0	-	-	-

The size of the catchable population of signal crayfish was also estimated for Lake Pobłędzie based on the Tsukerzis (1989) formula, which is used to determine the abundance of the commercially-sized population: N = 1.4 L × P, where: N – population abundance of commercially-sized crayfish (specimens), L – abundance of commercially-sized crayfish caught in traps within an hour (specimens ha^{-1}), P – area inhabited by crayfish (ha). According to this formula, the catches conducted with 58 traps for 10 hours over three subsequent nights indicate that the abundance of the population available for commercial catches (exceeding 10 cm) in the studied area of 1.65 ha was 4428 specimens. When recalculated into area units, it was 2684 specimens ha^{-1}.

According to the Petersen method, the population abundance of catchable signal crayfish in Lake Pobłędzie is 2094 specimens ha^{-1}, which, at the average body weight of the captured specimens (51.9 g) equals 109 kg ha^{-1}. If the correction reported by Kozák (2001) is applied and the abundance is increased by 25%, then the population abundance is 2792 specimens ha^{-1}, which is close to the result calculated with the Tsukerzys method (Tsukerzys 1989). Most probably, these figures are closer to the actual catchable population density of the signal crayfish in Lake Pobłędzie. The relatively low abundance of spiny-cheek crayfish in Lake Pobłędzie is the result of the drastic decline in its numbers that has been observed since 2004. This phenomenon has been observed since 2002 in many other Polish waters, which may indicate that the cause is an infectious disease specific to this crayfish species (Krzywosz 2004).

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STRESZCZENIE

SZACOWANIE WIELKOŚCI POPULACJI ŁOWNEJ RAKA SYGNAŁOWEGO (*PACIFASTACUS LENIUSCULUS* (DANA)) I RAKA PRĘGOWATEGO (*ORCONECTES LIMOSUS* (RAF.)) W JEZIORZE POBŁĘDZIE (PÓŁNOCNA POLSKA)

W 2004 roku w jeziorze Pobłędzie zasiedlanym przez raka sygnałowego, *Pacifastacus leniusculus* i raka pręgowatego, *Orconectes limosus*, przeprowadzono znakowanie i powtórne połowy, w celu oszacowania wielkości populacji łownej raków metodą Petersena. Połowy prowadzono na wyznaczonej powierzchni kontrolnej o wielkości 1,65 ha, przy użyciu 58 szt. pułapek typu „Evo". Średnia długość ciała raków sygnałowych wynosiła 11,7 ± 1,1 cm (7,6-15,0 cm), a raków pręgowatych 9,3 ± 0,65 cm (7,5-10,7 cm) (tab. 1). Rozkład wielkościowy wskazuje, że raki sygnałowe o długości do 11,0 cm były mniej licznie reprezentowane w połowach niż mogłoby to wynikać z ich spodziewanego udziału w populacji naturalnej (tab. 2). Wyliczona ze wzoru Petersena liczebność populacji łownej przypadającej na jednostkę badanej powierzchni jeziora wyniosła około 2094 szt. ha^{-1} raka sygnałowego i 127 szt. ha^{-1} raka pręgowatego. Zważywszy na duże prawdopodobieństwo niedoszacowania udziału raków sygnałowych o wielkości do 11,0 cm, przyjmuje się, że rzeczywista wielkość populacji łownej tego gatunku może być wyższa o około 25%. Stosunkowo niewielka ilość raka pręgowatego w jeziorze Pobłędzie jest efektem obserwowanego od 2004 r. gwałtownego spadku jego liczebności. Od 2002 r. zjawisko to jest obserwowane również w wielu innych wodach Polski, co może wskazywać, że przyczyną jest specyficzna dla tego gatunku choroba zakaźna.