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RESEARCH PAPER

# A New Design of Crayfish Traps Reduces Escaping and Improves Opportunities for Long-Term Catching

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**Abstract**

From the most often used traps caught crayfish can escaping during the day. This reduces trapping yield. Therefore, those tools are used to the one-night catching. New tool for long-term catching was tested. The ability to retain crayfish inside a trap and the catch efficiency of this trap named Vulkan were compared to the popular trap named Evo in artificial and wild conditions. The tested crayfish traps differed significantly in their ability to retain crayfish. After four days (96 h) of observation in artificial conditions, 65.2% crayfish inserted into traps had escaped from Evo traps compared with 2.4% in the case of Vulkan traps. Evo traps had statistically significant ($P<0.05$) higher the catch efficiency as catch per unit effort (CPUE) than Vulkan traps during one-night catching in the lakes. Research showed that Vulkan traps effectively prevent the escape of caught crayfish also during the daylight surpassing in this case Evo traps and are better for use in long-term catch. They can be the basis for new research methods collecting crayfish not only for one-night catch but for an extended period of time. Also in a commercial fishery Vulkan traps may reduce the catch effort.

*Keywords*: trap, catching, crayfish, catch efficiency, catch per unit effort (CPUE)

## Introduction

Crayfish are caught using various passive and active methods, such as by hand catch, baited stick, traps with our without bait, nets, electro-fishing and diving (Kossakowski, 1966; Westman, 1991; Policar and Kozák, 2005; Kozák *et al*., 2015). However, there is no single most effective method that would be appropriate under all conditions. Therefore, the choice of fishing methods should be adapted to the specific characteristics of the environmental conditions and expected resources of the caught crayfish population (Souty-Grosset *et al*., 2006). Choosing the right catch strategies is the primary factor determining the effectiveness of fishing and its profitability (Jusilla, 1995; Caffey *et al*., 1996).

The most popular methods of catching crayfish are various types of traps, whereby crayfish are attracted to the inside of the trap by bait affixed inside it. There are various types of traps (Fjälling, 1995, 2011; Romaire, 1995; Ackefors, 1998). The principle of this type of tool is based on the maximum obstruction to escaping crayfish, which will enter the inside of the trap. Catches are carried out mainly at night, when crayfish are the most active. Crayfish are removed from the traps before sunrise because at daylight, they trying to escape. They are able to escape from practically all types of crayfish traps; however, are known modifications that limit the escape of caught crayfish (Westman *et al*., 1979). New tool with maximum anti-escape characteristics have been also developed in Poland (Ulikowski, 2007). The prototype of this trap named Vulkan was presented in 2008 at the 17th Symposium of the International Association of Astacology "Freshwater Crayfish" in Kuopio, Finland (Ulikowski and Krzywosz, 2008).

The aim of this study was to compare the ability to retain crayfish inside a trap and the catch efficiency of two crayfish traps: the construction named Vulkan and the popular construction named Evo. Which of two types of traps are better to the one-night catching and which to the long-term catching?

## Materials and Methods

### Design Features of Both Types of Crayfish Traps

The trap named Vulkan is a construction developed at the Inland Fisheries Institute in Olsztyn, Poland (Ulikowski, 2007). The design is made of stainless steel wire with a diameter of 4 mm and the

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incorporation of netting (mesh size 10 mm). The basic skeleton of the structure is formed of one ring (diameter 80 cm) and two semi-circular tension arcs. The specially curved connector allows the trap to be folded for transport and when unfolded, the entire structure of the trap stiffens. After it is opened, a trap resembles the shape of a volcano or a mushroom hat (Figure 1). One circular entrance to the trap has a diameter of 10 cm and is positioned in the vertical plane at the top of the structure. The inlet has a plastic tube with a height of 10 cm inserted directly into the interior of the trap. The purpose of this tube is to prevent the escape of crayfish that have entered the trap. The bait is inserted directly into an enclosure through the inlet. The caught crayfish are removed through the closable opening by a pull cord on the bottom.

Trap named Evo is popular in Scandinavia and is often used in many countries around the world as tool to catch crayfish (Westman *et al*., 1979). It has the shape of a horizontal cylinder with a length of 50 cm and a diameter of 25 cm (Figure 2). The design is made of steel spring wire, which enables it to be folded for transport and ensures adequate stiffness when unfolded into a working position. The netting covers a steel skeleton (mesh size 20 mm). The trap has two opposite funnel-shaped entrances, which are situated in a horizontal plane at both ends of the cylinder. They are made of netting and completed by slotted inlet openings with a height of approximately 10 cm. The trap has hook installed for bait in the middle of the structure. Inserting and removing bait and caught crayfish is possible by tilting the closure on one of the cylinder bases.

**Figure 1.** Crayfish trap Evo prepared to catch.

**Figure 2.** Crayfish trap Vulkan.

**Study: The Ability to Retain Caught Crayfish Inside the Trap**

The study was conducted in the Department of Sturgeon Fish Breeding in Pieczarki in early October. One concrete pond (measuring 20 × 10 m) was flooded with water to a depth of 1.5 m. Ten traps of each type (Evo and Vulkan) were placed into the pond, one every few meters. Inside each trap were inserted 10 individual (3 males and 7 females) adult signal crayfish (*Pacifastacus leniusculus* Dana, 1852). The average total body lengths (TL ± SD) of male and female crayfish were 122 ± 19 mm (102-139) and 115 ± 20 mm (91-130), respectively. In addition, the crayfish that were inserted into Evo traps were marked on the carapace with waterproof paint, in order to differentiate escaped crayfish from both types of traps. During the experiment, there was no food or bait in the traps. Traps with crayfish were placed on the bottom of the pond on four days (96 h). During the tests, the average water temperature was 12.5°C. The counting of crayfish in traps was carried out twice per day (8:00 and 20:00). The sex and numbers of crayfish that exited the traps were recorded.

**Study: Catch Efficiency Under Wild Conditions**

The study was conducted in two lakes in north-eastern Poland: Lakes Mauda (54°19'38" N, 22°47'37" E) and Pobłędzie (54°18'25" N, 22°45'17" E). Lake Mauda has an area of 37.9 ha, a maximum depth of 17.5 m and an average depth of 5.9 m and Lake Pobłędzie, 57.6 ha, 14.9 m and 6.1 m, respectively. The two lakes are located close to each other (3 km apart). In both lakes, populations of two American crayfish species coexist: spiny-cheek crayfish (*Orconectes limosus* Raf., 1817) and signal crayfish (*P. leniusculus*) (Krzywosz, 2006; Krzywosz and Krzywosz, 2001, 2002; Krzywosz *et al*., 2006). The catches were conducted during two consecutive nights (one effort per lake), at the turn of September and October. On each lake, the crayfish catch was carried out using two types of traps: Evo (30 units) and Vulkan (20 units). Both types of traps were deployed to alternate every 20 m in the littoral zone of lakes (at a depth of 0.5-6.0 m) at 18:00 and lifted at 6:00. Small Cyprinid fish were used as bait. The water temperature was 15.0°C in both lakes. Species, abundance and sex of individually caught crayfish in each particular type of trap were recorded. The measurements of total body length (with an accuracy of 0.1 mm) and crayfish body weight (accurate to 0.1 g) were performed.

**The Indicators Calculated and Statistical Analysis**

The catch efficiency indicator specified as catch per unit effort (CPUE), which in this study, is the average number of caught crayfish per trap per night. Sex ratios (male:female) and changes in the abundance of caught crayfish for both types of traps were calculated. Means values of standard deviations (SD), standard errors (SE), total body lengths (TL) and body weight of caught crayfish were calculated. The statistical significance of the differences between mean values were tested using the computer program STATISTICA 8.1 (StatSoft, Poland) using the Student's t-test with a significance level of $\alpha = 0.05$.

## Results

**Comparison of The Ability to Retain Caught Crayfish Inside the Trap**

There were significant differences in the ability to retain caught crayfish in the trap between the tested traps. The abundance of caught crayfish in Evo traps declined, while that of Vulkan traps increased (Figure 3). After four days (96 h) of exposure, 26.7% (n=8) of males and 42.9% (n=30) of

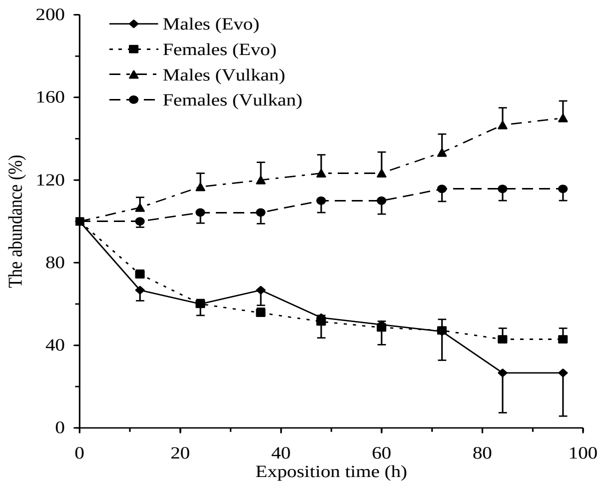


**Figure 3.** Changes in the abundance of crayfish placed inside two types of traps: Evo and Vulkan. Points and whiskers describe mean values and standard errors (SE).

females remained in Evo traps. In contrast, the abundance of caught crayfish in Vulkan traps increased at the same time to 50.0% (n=15) for males and to 15.7% (n=11) for females, respectively. Within four days (96 h) of observation, 65.2% of crayfish (females n=40, males n=22) fled from Evo traps, whereas only 2.4% (females n=1, males n=1) fled from Vulkan traps (Figure 4). In addition, 32.9% (n=26) of crayfish that escaped from Evo traps were recapturing in Vulkan traps.

### Comparison of The Catch Efficiency of Traps Under Wild Conditions

During the crayfish catches in the lakes, we found statistically significant (Student's t-test, P<0.05) differences between the studied traps in the case of total length and body weight of caught crayfish and CPUE. The index value of CPUE amounted to 2.1 crayfish per trap per night for Evo traps in contrast to 1.25 crayfish per trap per night for Vulkan traps. During the control of the number of caught crayfish in traps, 33% of Evo traps were found to be empty as compared with 25% of Vulkan traps. Total length and body weight of crayfish that were caught in Evo traps were greater compared with those caught in Vulkan traps. The sex ratio (Males:Females) of caught crayfish was similar for both types "of traps (Table. I). In both types of traps, there were 3.4 to 4 times more males caught than females.

The species of caught crayfish did not significantly affect the CPUE of tested traps during the crayfish catches on a both lakes. In Evo traps more of both species, signal crayfish and spiny-cheek crayfish, were caught than in Vulkan traps (Figure 5).

The most numerous group was crayfish in the TL 80-89 mm range in the case of Vulkan traps and in the 90-99 mm range for Evo traps (Figure 6).

## Discussion

Our research shows that the design of Vulkan traps, which have a plastic tube at the entrance to the trap, significantly impedes the escape of caught crayfish from the trap. In contrast, caught crayfish escape at a rapid pace from the popular, standard Evo traps and 96 h after being caught, only 34.8% remain in traps. In fact, a very fast escape of caught crayfish from the traps has also been described by other authors. According to Kozák *et al*. (2001), 39.7% of caught crayfish escape from Evo traps after 24 h, similar to the figure reported in our study. On the other hand, Pfister and Romaire (1983) argue that at 12, 24 and 48 h in traps 84, 80 and 64% of initially

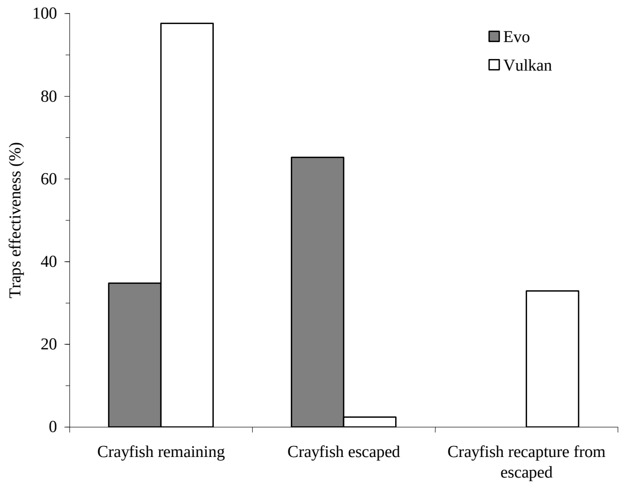


**Figure 4.** Comparison of the ability to retain (96 h exposure) caught crayfish inside two types of traps: Evo and Vulkan.

**Table 1.** Comparison of effects the crayfish trapping on the two lakes using two types of traps: Evo and Vulkan. n: number of caught crayfish, TL: total body length, W: body weight, CPUE (catch per unit effort): the catch efficiency, SD: standard deviation. The mean values (mean) in the columns marked with a different letter index indicate statistically significant differences (Student's t-test, P<0.05)

| Type of traps | n | Sex ratio Males: Females | Empty traps | TL | | | W | | | CPUE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | SD | Min-max | Mean | SD | Min-max | Mean | SD | Min-max |
| | | | [%] | [mm] | | | [g] | | | | [crayfish $trap^{-1}$ $night^{-1}$] | |
| Evo | 126 | 3.4 : 1 | 33 | $100.4^A$ | 14.5 | 77.0-141.0 | $35.5^A$ | 19.6 | 10.9-104.5 | $2.10^A$ | 2.06 | 0-8 |
| Vulkan | 50 | 4.0 : 1 | 25 | $91.8^B$ | 13.0 | 69.0-118.0 | $26.5^B$ | 13.0 | 9.8-73.2 | $1.25^B$ | 1.37 | 0-6 |

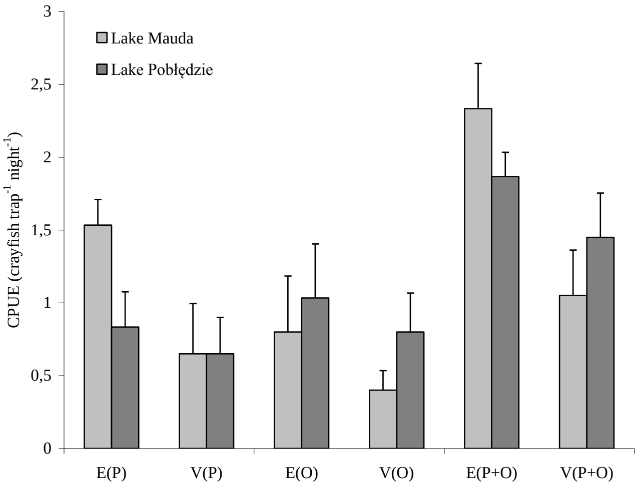


**Figure 5.** Comparison the catch efficiency (CPUE) of two types of traps: Evo (E) and Vulkan (V) on the two lakes where populations of two American crayfish species coexist: signal crayfish (P) and spiny-cheek crayfish (O). Bars represent mean values and whiskers standard errors (SE).

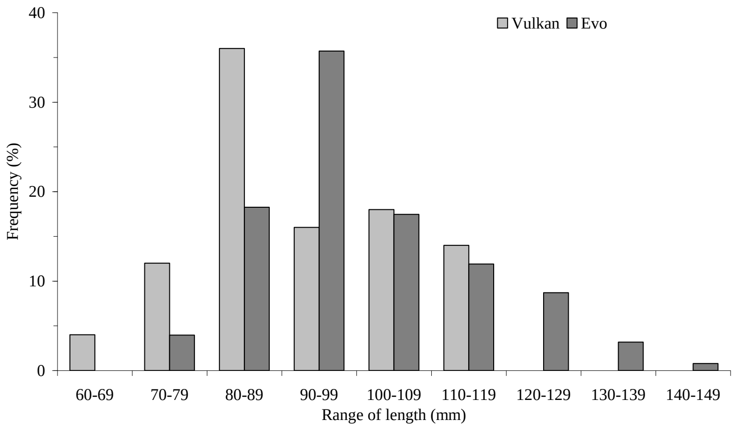


**Figure 6.** Distribution of frequency caught crayfish by two types of traps: Vulkan and Evo (n=126 and 50 respectively) in the following ranges of total body length (TL).

caught crayfish remain, respectively. The design of the entrance to the trap significantly affects to the ability of the trap to retain caught crayfish (Campbell and Whisson, 2001). In our study, by inserting a plastic tube into the entrance, after 96 h of exposure, 97.4% effectiveness of protection against escaping caught crayfish was obtained. Such a modification in the case of Evo traps allows for 100% effectiveness in the retention of caught crayfish trapped overnight (Westman *et al*., 1979).

According to Westman *et al*. (1979), during daylight, crayfish escaped from the inside of the trap more often than at night. Therefore, emptying the trap of caught crayfish twice or three times at night increases the total catch in them. Crayfish, like other animals, avoid conflicts and struggles as far as possible (Smith and Price, 1973). Therefore, they try to escape from the trap when their density increases. Also, some crayfish may avoid the entrance to the traps in which there are already other individuals. Breithaupt and Eger (2002) showed that crayfish can scare by a strong burst of urine in the direction of a potential competitor. This action is designed to avoid direct combat, which can lead to unnecessary injuries and loss of limbs.

Harlioğlu (1999) showed that the frequency of escape and relocation to other traps was higher in the case of signal crayfish compared with narrow clawed crayfish (*Astacus leptodactylus* Esch.). According to Westman *et al*. (1999), signal crayfish also have a greater tendency to escape from the traps in comparison to noble crayfish (*Astacus astacus* L.).

When crayfish are caught only during the night, modifying the construction of the crayfish trap by inserting a plastic tube into the entrance of the trap may have a negative impact on CPUE. According to Westman *et al*. (1979), the CPUE of Evo traps decreased from 2.08 to 1.42 crayfish per trap per night. The authors used a modification of the entrance to the trap similar to the one used in our research.

The values of CPUE obtained in our study were similar to those obtained by Krzywosz and

Krzywosz (2002) on Lake Pobłędzie in 1996-2001 using Evo traps. In the case of Vulkan traps, the values of CPUE were also similar to those obtained by other authors using traps to catch different crayfish species (Westman *et al*., 2002; Taugbøl, 2004; Tulonen *et al*., 2008; Zimmerman and Palo, 2011).

Another factor affecting the differences in catch efficiency of both types of traps are their differing constructions. Evo traps have two entrances to the trap arranged on a horizontal plane and Vulkan traps have one entrance into the trap on a vertical plane on top of the construction. This arrangement of entrances to the trap favours the first of these types of traps because it is easier for crayfish to find the entrance to trap. Also, the number of entrances is one of the decisive factors affecting catch efficiency. Westman *et al*. (1979) reported a CPUE of 2.08 crayfish per trap per night for standard Evo traps (two entrances to the trap) and 0.83 crayfish per trap per night for modified Evo traps (one entrance to the trap). According Pfister and Romaire (1983) the catch efficiency of traps increases with the number of entrances to the trap, but also decreases the ability to retain crayfish within the trap. Other researchers suggest a significant impact of the construction of traps on their catch efficiency (Westman *et al*., 1979; Fjälling, 1995; Romaire, 1995; Ackefors, 1998; Campbell and Whisson, 2001; Policar and Kozák, 2005; Kozák *et al*., 2015).

In our study, there was a significant difference ($P<0.05$) in the body size of crayfish caught in the tested traps. This was probably a result of the use of different mesh sizes for the construction of these traps (Vulkan trap 10 mm and Evo trap 20 mm). Therefore, smaller individuals can escape from the inside of the Evo trap. The mesh size of the netting used to construct the traps determines the selectivity of such a tool (Qvenild and Skurdal, 1989; Skurdal and Taugøl, 1994; Bolat *et al*., 2010; Johnsen *et al*., 2014). The size of the individuals caught in our study was similar to that obtained by the other researchers using Evo traps in the same area of research (Krzywosz and Krzywosz, 2002; Krzywosz, 2006; Krzywosz *et al*., 2006; Chybowski, 2013).

In our studies carried out on two lakes, males dominated both catches. Similar results were obtained in late September and October in 1999 on Lake Pobłędzie by Krzywosz and Krzywosz (2002). However, in other years, the authors no longer observed male dominance in the catch. Their studies were likely conducted at a point in time associated with the beginning of the mating season or with molting in females, which were less active than males at that time (Policar and Kozák, 2005).

The design solutions applied to the Vulkan traps effectively prevent the escape of caught crayfish at least by four days (96 h), surpassing in this regard the Evo traps, but under one-night catching Evo traps have higher catch efficiency. Vulkan traps may be used in a long-term catching lasting many days. In this way, Vulkan traps can be left for several days on fishing grounds and caught crayfish don't escape from the traps. They can be the basis for new research methods collecting crayfish not only for one night but for an extended period of time. Also in a commercial fishery Vulkan traps may reduce the catch effort, because traps support may be reduced to once per day (evening only) to remove caught crayfish and to bait exchange.

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