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## The estimation of population size of northern crested newt (*Triturus cristatus*) on the locality Suchá Rudná in the Jeseníky Mts. Czech Republic

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### Summary

The purpose of the study is to answer two questions: What is the population size of the crested newts at the site Suchá Rudná and may the capture – recapture method be used for estimation of the size of crested newt populations?

The population size of *Triturus cristatus* was estimated by the capture - recapture method at the locality Suchá Rudná in the Jeseníky Mts. in spring 2000. Since it was not clear whether the method may be applied to newts, we had to check the validity of all the conditions in which the method can be used. The design of the observation was modified so that the dispersion of the released newts could be observed. The results show that if the captured newts are released not further then ten meters from the place of their capture or if the interval between the release and recapture is more then two days, the conditions of the method are met. The estimated abundance of the crested newt population is  $390 \pm 40$  individuals in a pool 50 m long and 20 m broad. The newts *T. alpestris* and *T. vulgaris* also inhabit the pool. Their abundance is  $60 \pm 30$  individuals and 7 or more respectively.

**Key words:** *Triturus cristatus*, *T. alpestris*, *T. vulgaris*, capture - recapture method, Petersen method, abundance, homing, Jeseníky Mts., Czech Republic.

### Schätzung der Populationsgröße des Kammolches (*Triturus cristatus*) in der Lokalität Suchá Rudná im Jeseníky Kreis – Tschechische Republik

Ziel der Studie war die Beantwortung von zwei Fragen: Wie groß ist die Populationsgröße des Kammolchs in Suchá Rudná im Jeseníky Kreis und kann die Fang-Wiederfang-Methode zur Schätzung der Größe von Kammolchpopulationen verwendet werden?

Die Größe der Kammolchpopulation in der Lokalität Suchá Rudná im Jeseníky Kreis wurde im Frühjahr 2000 durch die Fang-Wiederfang-Methode geschätzt. Da nicht bekannt war, ob die Methode für Molche angewendet werden kann, musste die Gültigkeit der Voraussetzungen für die Anwendung der Methode geprüft werden.

Der Versuch wurde so angelegt, dass die Verteilung der freigelassenen Molche beobachtet werden konnte. Die Ergebnisse zeigen, dass die Voraussetzungen der Methode erfüllt werden, wenn die gefangenen Molche nicht weiter als 10 m vom Fangort ausgesetzt werden oder wenn der Zeitraum zwischen Aussetzung und Wiederfang zeit Tage übersteigt. Die geschätzte Abundanz der Kammolchpopulation in dem 50 m langen und 20 m breiten Gewässer beträgt  $390 \pm 50$  Individuen. *Triturus alpestris* und *T. vulgaris* leben ebenfalls im Gewässer. Ihre Abundanzen betragen  $60 \pm 30$  und 7 oder mehr Individuen.

**Schlagwörter:** *Triturus cristatus*, *T. alpestris*, *T. vulgaris*, Fang-Wiederfang-Methode, Petersen Methode, Abundanz, Reviertreue, Jeseníky Kreis, Tschechische Republik.

## Introduction

The crested newt (*Triturus cristatus*) is listed in Appendix II and IV of the NATURA 2000 program. Reliable data about population size are missing for the Czech Republic.

The site Suchá Rudná in the Jeseníky Mts. was selected for our preliminary study of the population size because of its high density compared to other sites in the Czech Republic. Between the years 1996 and 2000, an alarming reduction in the population sizes occurred which has been caused by introduction of fish. This site was discovered in 1996 (ZAVADIL unpubl.).

The capture-recapture method was used for estimation of abundance of the crested newt population. There are some conditions for the use of the method, which must be met.

The capture-recapture method (Petersen method) requires the following conditions:

- a) The mortality of the captured individuals must be lower than sensitivity of the method.
- b) The migration of all individuals across the border of the observed site must be lower than sensitivity of the method.
- c) There must be non-dispersal distribution of individuals over the locality between the release of marked newts and their recapture (approx. 12 h, see table 1).
- d) Either absence of homing or respecting the homing where it occurs.
- e) The difference in the probability that a marked or an unmarked individual will be caught must be lower than sensitivity of the method.

The capture-recapture method (SCHNABEL 1938) was modified so that meeting the conditions could be verified.

That is because the method was used for amphibians in Czech territory four times only (CÍHAR 1989, HODROVÁ 1975, LUKÁŠ 1978, ZAVADIL et al. 2000).

## Material and methods

The site is situated in the north of Suchá Rudná village in the Jeseníky Mts. (50°04' N, 17°22' E, 5970a sq.) at an altitude of 695m above the Baltic sea level. It is a flooded gold quarry in the shape of a sink which is 20 m wide and 50 m long (see fig. 1) and 60 m deep (SCHMIDTOVÁ pers. mitt.).

There are countryside buildings south of the pool, a slope covered with mixed forest in the east of the pool, a field with natural seeding of woody plants in the north and a meadow in the west.

The site is precious by its high variety of species of pelagic plankton and water insect and by their abundance.

The capture-recapture method is based on the idea that the ratio of marked and unmarked individuals in the captured sample and in the pool is approximately the same. It is necessary to carry out the recapturing more than once and to have about 50% of marked individuals in the pool for better estimation. That's why we carried out the estimation for five days (see tab. 1) and each captured newt was marked.

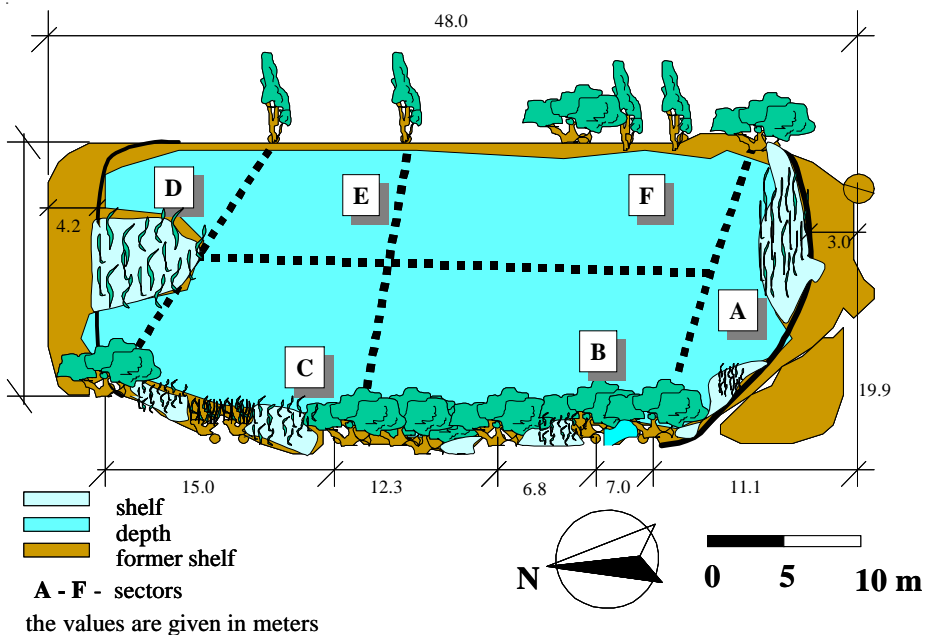


Fig. 1: The site a flooded gold quarry. Because of decrease in the water level between the first and the second five-day measurement (8<sup>th</sup> –12<sup>th</sup> of May and 12<sup>th</sup> –16<sup>th</sup> of June 2000) the former shelf is depicted there.

Das Versuchsgewässer eine geflutete Goldmine.

night		number of observ.	capture			release			sector	time of movement of individuals along the pool [in hours]
			from	to	middle	from	to	middle		
12. 6.	13. 6.	1	23:00	02:00	00:30	10:00	11:00	10:30	A	
13. 6.	14. 6.	2	00:00	02:00	01:00	09:00	09:00	09:00	***	15
14. 6.	15. 6.	3	23:00	02:00	00:30	10:30	10:30	10:30	A	16
15. 6.	16. 6.	4	22:20	00:00	23:10	10:25	10:25	10:25	***	13
16. 6.	17. 6.	5	22:45	00:50	23:45				A	13

\*\*\* - to the sectors where the newts were captured

Tab. 1: The plan of capturing and releasing for the second five-day measurement.

Versuchsplan von Fang und Freisetzung für die zweite fünftägige Messung.

Marking of the newts was provided during anaesthesia by cutting the last one part of the newt's digit. The anaesthetic, which was used, was 0.8 % water solution of phenoxyethanol (0.8 mililitre of phenoxyethanol in 1 litre of water).

Every newt was marked on maximum three digits so that its migration within the pool for at least the first two days could be checked. The system made it possible to check the movement of every individual only during the first two days. During the following three days, only the sectors of origin of the newts could be identified.

species	sex	number of individuals	standard deviation	95% confidence interval	
				from	to
<i>T. cristatus</i>	males; n=32	100	30	40	160
	females; n=23	190	70	50	330
	subadults; n=1	>1 (~50)	-	-	-
	total; n=56	350	100	160	530
<i>T. alpestris</i>	males; n=7	10	5	0	20
	females; n=16	70	30	10	120
	total; n=23	90	30	20	150
<i>T. vulgaris</i>	total	>1	-	-	-

Tab. 2: Estimates from 8<sup>th</sup> - 12<sup>th</sup> of May 2000. The “n” in column sex means the total number of marked individuals in the pool.

Schätzungen vom 8. - 12. Mai 2000. Das "n" in der Spalte sex entspricht der Gesamtzahl der markierten Tiere im Gewässer.

species	sex	number of individuals	standard deviation	95% confidence interval	
				from	to
<i>T. cristatus</i>	males; n=63	140	25	90	190
	females; n=87	160	20	120	200
	subadults; n=36	100	30	50	160
	total; n=168	390	40	330	460
<i>T. alpestris</i>	males; n=8	20	20	8	60
	females; n=21	20	1	21	25
	total; n=29	60	30	29	100
<i>T. vulgaris</i>	males	>4	-	-	-
	females	>3			

Tab. 3: Estimates from 12<sup>th</sup> – 16<sup>th</sup> of June 2000. The “n” in column sex means the total number of marked individuals in the pool.

Schätzungen vom 12. - 16. Juni 2000. Das "n" in der Spalte sex entspricht der Gesamtzahl der markierten Tiere im Gewässer.

Newt species *Triturus cristatus*, *Triturus alpestris* and *Triturus vulgaris* occurring in the pool were caught during two five-day periods (8 - 12 May and 12 - 16 June 2000) to verify conditions a) and b). The total numbers of marked individuals in the pool was the second day 57, the third day 124, the fourth day 164 and the last day 186 for the *T. cristatus* and 7, 18, 26 and 29 for *T. alpestris* during the second five days measurement. The total numbers of marked individuals can be found in the tables 2, 3 and 4 marked as an “n”.

The individuals from six different sectors were marked (see fig. 1). The sectors had roughly the same length of the coast. The scheme of releasing newts back into the pool is shown in table 1.

The formula A3 from Appendix was used for computation of abundance. The maximal root of the formula was found numerically and then it has been rounded. The formula A5 was used for standard deviation's estimate.

species	sex	number of individuals	95% confidence interval	
			from	to
<i>T. cristatus</i>	males; n=32	130	60	500
	females; n=23	160	70	700
	subadults; n=1	10	10	>1000
	total; n=56	350	200	750
<i>T. alpestris</i>	females; n=16	80	20	500
	total; n=23	160	40	700

Tab. 4: Estimates from 12<sup>th</sup> of June 2000 using newts that were marked during the first five-day period. According to the table the conditions a) and b) are met.

Schätzungen vom 12. Juni 2000 unter Verwendung von Kammolchen die während der ersten fünftägigen Periode markiert wurden.

The fact that conditions a) and b) of the capture – recapture method were met was verified comparing three sets of estimates. First the numbers of individuals for both five-day periods (see table 2 and 3) were compared. And then we compared the estimates of the numbers of individuals made on 12 June 2000 (see table 4) with each of the other two estimates (see table 2 and 3).

Although our data are not sufficient to describe relaxation of the wave of the population density (a trend to non-dispersal distribution; the Fick's law) of the tagged newts, which were released into the sector A (condition c), some relaxation of the population wave was noticed. The relaxation time is two days, but statistical significance is very high (approx.  $p = 0.3$ ).

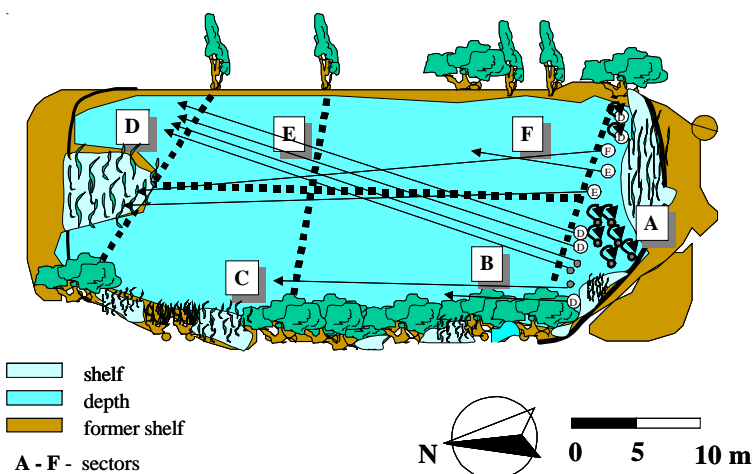


Fig. 2: A sample of movement of *T. cristatus* females in the time period between the first and the last captures, excluding individuals that were transferred during the observation. The letter in the circles means the sector of origin.

Beispiel für die Bewegung von Kammolch-Weibchen zwischen dem ersten und letzten Fang. Die Zahlen in den Kreisen entsprechen den Ursprungssektoren.

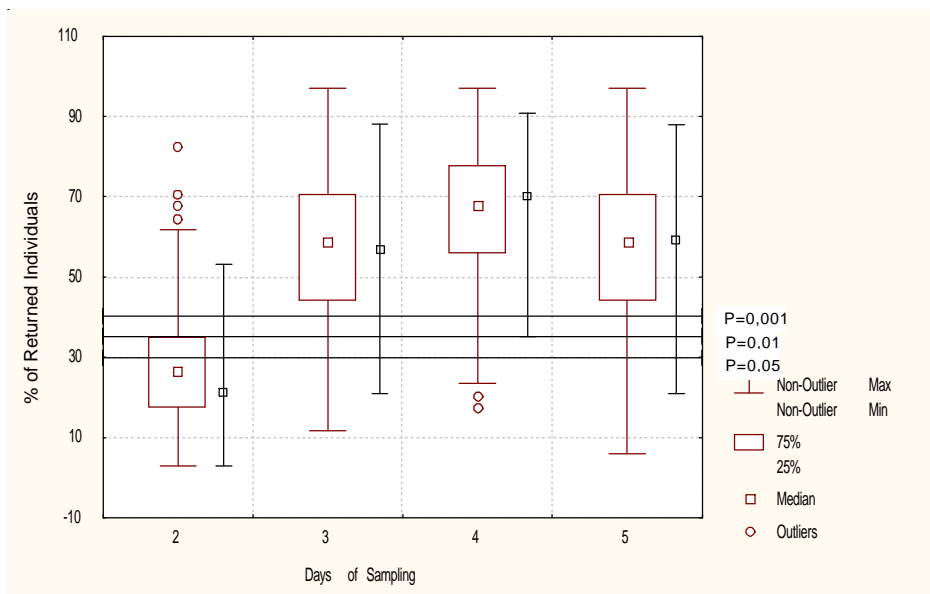


Fig. 3: Homing of adults of the crested newt *T. cristatus* released in sector A. The dashed lines indicate the thresholds for statistical significance of the return, which can be caused by random effect. For the statistical significance more then approx. 70% of confidence interval (CI) must be over the threshold line. The bold line shows 95% CI and box and whisker corresponds to 99% CI, which were computed nonparametrically from 2000 random simulations (see Appendix). Numbers of recapturing individuals were 9, 5, 7 and 5 from the 34 tested individuals. We did not notice any significant difference between adult males and females.

Reviertreue adulter Kammolche, die im Sektor A ausgesetzt wurden.

A statistically significant tendency ( $p < 0.03$ ) to return into their sector of origin (see fig. 2-3) was observed for both male and female newts in four days. This fact was used for verification of conditions c) and d).

We focused on the condition e) in our previous paper (ZAVADIL et al.2000), where our observation in Karlova Studánka in the Jeseníky Mts. was presented. The work is valid for *T. alpestris* and *T. montandoni* only. However, also in this study we did not prove any significant change in our estimates of the number of newts during the five days of the observation (four recaptures). So the condition e) seems to be met.

## Results and Discussion

### Verification of the conditions of the capture - recapture method

There is no evidence for mortality or migration of marked and unmarked individuals across the border of the pool, during the observation period, as shown in table 2-4. In the case of increased mortality or migration of marked individuals, the ratio of marked and

unmarked individuals would change, which would also cause a change in the result (the maximum likelihood estimation).

We did not make an analysis of the decrease in the number of marked individuals, which would not be detected by our data. However the collected data do not indicate that the condition a) or b) would not be met.

Subadult individuals of *Triturus cristatus* increased by about 50 individuals. This can be explained by the spring migration or by possible uncertainty in determination of subadult females.

Fig. 2 shows an example of some movement of crested newts between the sectors. The letters in the circles show the sectors where the newts were captured for the first time. Absence of a letter in a circle indicates that the sectors of capture and release were identical.

During the last five days period, the fastest movement between the two opposite sides of the pool (approx. 45 m) was noticed. The movement lasted 12 hours in the case of two females and 37 hours in the case of one male.

Fig. 3 shows the percentage of observed individuals, which after being released into the sector A returned back into their original sector, where they were recaptured. The individuals, which were removed during the observation, were excluded from the computation.

The second day (see fig. 3), the statistical significance of the return of a newt is very high (approx.  $p = 0.5$ ). This means that many newts were travelling for its original location for at least two days. For the other days the significance is below 0.03 ( $p < 0.03$ ) except for the 4<sup>th</sup> day where “p” is below 0.01.

The homing of newts must be considered a hypothesis, because it has been verified only once.

### **Estimation of abundance of newts *T. cristatus*, *T. alpestris* and *T. vulgaris***

As shown in table 3, the population of *T. cristatus* has the highest abundance in the site. Its total abundance is  $390 \pm 40$  individuals. It means roughly  $2.8 \pm 0.3$  individuals per 1m of coast.

Next population in abundance is the population of *T. alpestris*. Its abundance is  $60 \pm 30$  individuals. It means roughly  $0.4 \pm 0.2$  individuals per 1m of coast.

The smallest population is the population of *T. vulgaris*, consisting of only 7 noticed individuals.

### **Conclusion**

Abundance of the newt species *Triturus cristatus*, *T. alpestris* and *T. vulgaris* was estimated by capture - recapture method at the site Suchá Rudná in the Jeseníky Mts.

The estimated numbers are  $390 \pm 40$  for *T. cristatus*,  $60 \pm 30$  for *T. alpestris* and more then 7 for *T. vulgaris*.

By verification of each condition of the capture - recapture method, it was verified that the used method is suitable for estimation of the abundance of crested newts. We suppose

that this method can be used for other species of newts, too.

We consider the following rules important for the use of the capture - recapture method for newts.

- To release captured newts not further then 10 m away from the place where they were captured, especially in the case capturing is carried out daily.
- To catch newts all over the pool. It is because the capture – recapture method estimates only the part of the population, which has home range on the place of catching.

## Appendix

For one recapture the number of individuals can be estimated as

$$N = M * C / R \quad A1$$

The distribution of R is

$$p(R) = C_R^C * (M / N)^R * (1 - M / N)^{(C-R)} \quad A2$$

where M is total number of tagged individuals in the pool, C is number of individuals in the sample, R is number of tagged individuals in the sample and p is probability of recapture R tagged and C-R untagged individuals under condition that in the pool are N individuals.

According the SCHNABEL's paper (SCHNABEL 1938) the maximum likelihood estimation of the number of population (the extreme of distribution of A2) is maximal root of

$$\sum_i [(C_i - R_i) * M_i / (N - M_i)] = \sum_i R_i \quad A3$$

For  $M_i \ll N$  the maximal root of A3 can be approximated as

$$N = \sum_i [C_i * M_i] / \sum_i R_i \quad A4$$

where i is index of number of recapture (i = 1 the first recapture, i = 2 the second recapture ... etc.).

Standard deviation can be calculated as

$$SD(N) = \sqrt{\sum_i [M_i^2 C_i (C_i - R_i) / R_i] / \left( \sum_i R_i \right)^2} \quad A5$$

The N in the A4 is distributed by normal distribution.

The method of simulation of confidence interval (CI) which is shown on fig. 3:



1. The sample of individuals, which were released into sector A, was randomly simulated. The simulated sample had the same size as the real released sample and the ratio of individuals returned into their sector of origin was selected randomly.
2. The same number of individuals as we recaptured had been selected randomly until the number of returned individuals in the simulated sample equals to the number of returned individuals in the real recaptured sample.
3. It was repeated 2000 times.

## Acknowledgements

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