# RETURN RATES AND LONG-TERM CAPTURE HISTORY OF AMPHIBIANS IN AN AGRICULTURAL LANDSCAPE NEAR BONN (GERMANY)

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## INTRODUCTION

In the context of the long-term study "development of amphibian habitats in an agricultural landscape" amphibian populations of seven native species in an arable landscape near Bonn (Germany) were monitored during eleven years (1989 – 1995, 2000 – 2003, cf. Schäfer, 1993; Kneitz, 1997). Data presented here focus on return rates and minimum ages of long-lived individuals in the field of two frog and one newt species. These parameters influence maintenance and stability of amphibian populations and thus are important concerning ecology and conservation of species.

## STUDY AREA AND METHODS

The study focuses on a pond system with two natural and three artificial waterbodies. Using permanent drift fences with pitfall and funnel traps it was possible to catch and record most of the specimens that reached and quit the ponds throughout the whole year. One aim was to estimate minimum survival rates of the species by capture-mark-recapture techniques. For the anuran species — agile frog *Rana dalmatina* and common frog *R. temporaria* — two individual marking methods were applied: implantation of passive integrated transponders (PIT) and toe-clipping. The great crested newts *Triturus cristatus* were registered by photo identification of the belly pattern. Analyzing data of individually marked specimens we were able to estimate recapture rates for adults from spawning period 2001 to 2003.

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## RESULTS

### Return Rates

***Rana dalmatina* — agile frog.** In 2001 the population of the agile frog consisted of 939 adult specimens (340 females, 599 males). Return rates from one year to the next were about 50% in both periods (Fig. 1). Return rates of males ranged from 55 to 58% and were significantly higher than these of females with 38 to 42% ($\chi^2 = 15.8$,

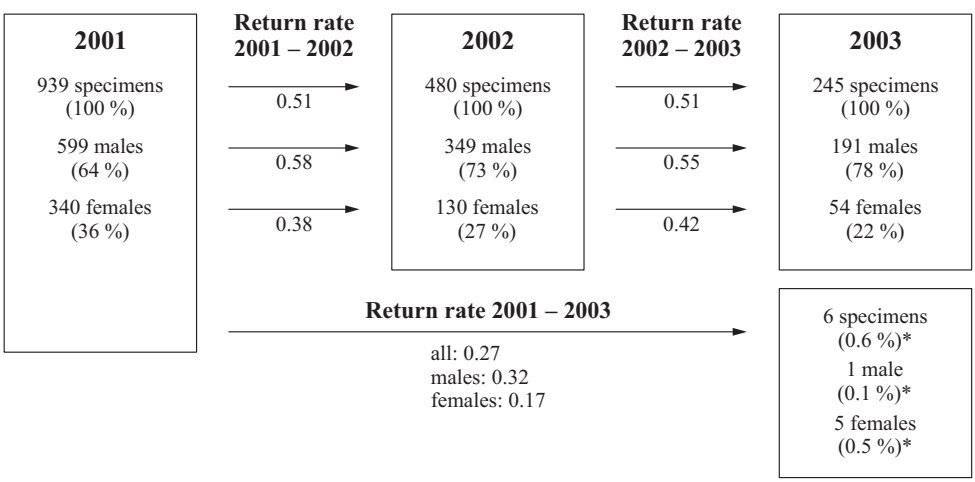


**Fig. 1.** Return rates of *Rana dalmatina* males and females 2001 – 2003. * Percentage of recaptured specimens from 2001.

$p < 0.001$). Consequently sex ratio within our sample increased from 64% males in 2001 up to 78% in 2003. Nearly all specimens returned to their breeding ponds every year; only 0.6% left out the spawning period 2002. At least 27% of all frogs (males: 32%, females: 17%) took part in reproduction over all three years.

***Rana temporaria* — common frog.** In 2001 a total of 423 individuals (202 females, 221 males) of *R. temporaria* were captured. Return rates ranged from 17 to 30% (Fig. 2) and were thus much lower than those of the agile frog ($\chi^2 = 45.7$, $p < 0.001$). Only a minority of the population (8%) reproduced all three years. Just six specimens (1.4%) overleaped the breeding season in 2002, i.e., came to their spawning site only in 2001 and 2003. Sex ratio was more balanced than in R. *dalmatina* populations (Fig. 2). No significant differences between return rates of males and females were found ($\chi^2$ test).

***Triturus cristatus* — great crested newt.** In 2001 altogether 170 adult specimens of the great crested newt (101 females, 69 males) were registered individually. 21% returned to their breeding pond in the following year and 11% of them were observed again in the last year (Fig. 3). Differences between return rates in 2002 and 2003 were not significant. Only 3% (6% males, only 1% females) took part in the reproduction over all three years. Because of the small sample size interpretations concerning different return rates of the sexes are not possible.

## Long-Term Capture Histories

***Rana dalmatina* — agile frog.** Twelve *Rana dalmatina* adults (nine males, three females) individually marked as metamorphs between 1993 and 1995 were captured again from 2001 to 2003 (Table 1). Minimum ages range from six to ten years. One male that metamorphosed in 1993 at least came back in all three seasons from 2001

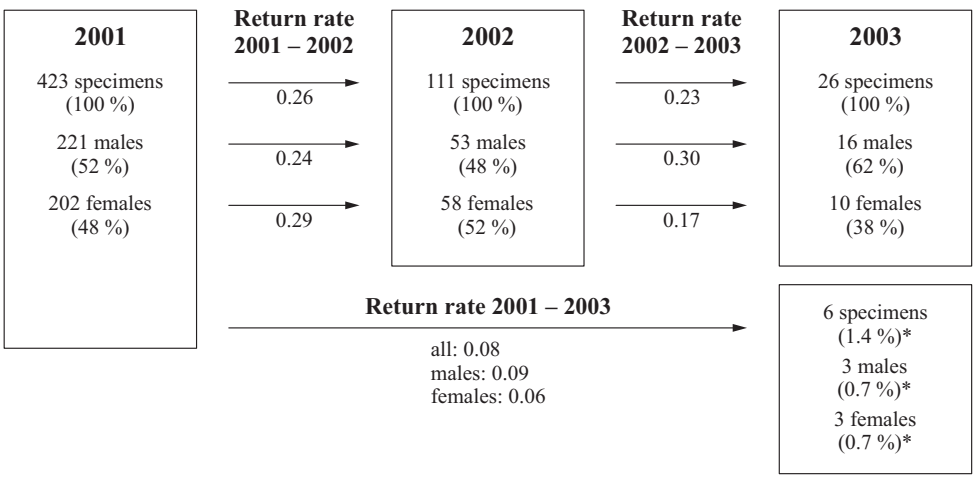


**Fig. 2.** Return rates of *Rana temporaria* males and females 2001 -2003. *, Percentage of recaptured specimens from 2001.

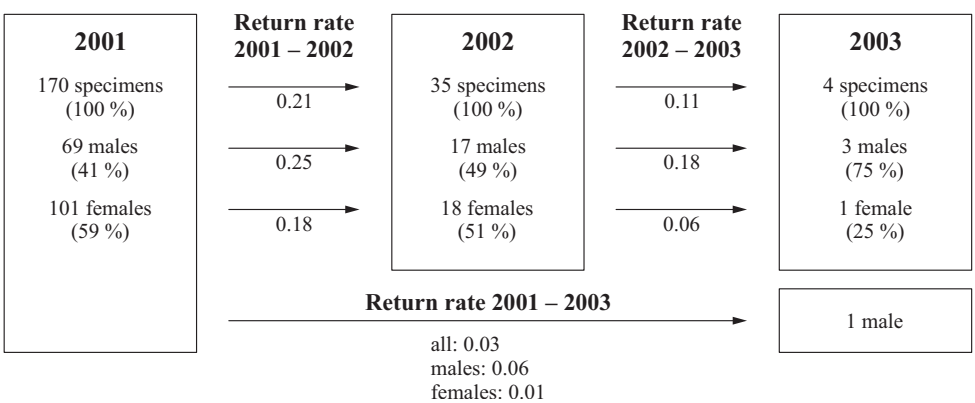


**Fig. 3.** Return rates of *Triturus cristatus* males and females 2001 – 2003.

to 2003 and thus reached an age of ten years. Most of these old specimens (10 animals) were observed in the same pond in which they hatched many years ago. Only two individuals were found in other water bodies within distances of a few hundred meters from their pond of hatch.

***Rana temporaria* — common frog.** Eight specimens of the common frog (two males, six females) marked as metamorphs between 1991 and 1995 could be observed again between 2001 and 2003 (Table 2). Consequently ages range 7 – 11 and 6 – 10 years for females and males, respectively. Four individuals changed between hatching site and spawning pond.

***Triturus cristatus* — great crested newt.** Two females and one male of *Triturus cristatus* first captured between 1995 and 1997 as adults could be recognized again in 2001 – 2003 (Table 3). During this period the population grew from 40 to 170 individuals. Those two females belonged to the first great crested newts, which colonized six respectively eight years after the completion the artificial ponds as adults. Minimum ages — estimated by individual recognition of adults — range between eight and ten years.

**TABLE 1.** Recaptured *Rana dalmatina* from the Period 1993 – 1997

| Number of specimens | Sex | Year of marking* | Year(s) of recapture | Age at last capture, years | Recapture place |
|---|---|---|---|---|---|
| 1 | ♂ | 1993 | 2001 – 2003 | 10 | same pond |
| 1 | ♂ | 1993 | 2001 – 2002 | 9 | same pond |
| 1 | ♂ | 1994 | 2003 | 9 | same pond |
| 3 | ♀ | 1994 | 2001 | 8 | same pond |
| 1 | ♂ | 1994 | 2002 | 8 | same pond |
| 2 | ♂ | 1994 | 2001 | 7 | same pond |
| 1 | ♂ | 1995 | 2002 | 7 | other pond (920 m distance) |
| 1 | ♂ | 1995 | 2001 | 6 | other pond (800 m distance) |
| 1 | ♂ | 1995 | 2001 | 6 | same pond |

* Marked as metamorph.

**TABLE 2.** Recaptured *Rana temporaria* from the Period 1993 – 1997

| Number of specimens | Sex | Year of marking* | Year(s) of recapture | Age at last capture, years | Recapture place |
|---|---|---|---|---|---|
| 2 | ♀ | 1991 | 2002 | 11 | same pond |
| 1 | ♀ | 1991 | 2001 | 10 | other pond (825 m distance) |
| 1 | ♂ | 1991 | 2001 | 10 | other pond (925 m distance) |
| 1 | ♀ | 1995 | 2001 – 2003 | 8 | other pond (860 m distance) |
| 1 | ♀ | 1995 | 2001, 2002 | 7 | same pond |
| 1 | ♀ | 1995 | 2002 | 7 | same pond |
| 1 | ♂ | 1995 | 2001 | 6 | other pond (1275 m distance) |

* Marked as metamorph.

## DISCUSSION

### Return Rates

Because in all three species only a small minority of individuals left out the spawning period 2002 (0.6% for *Rana dalmatina* and 1.4% for *R. temporaria*, and only one individual of *Triturus cristatus*) one can assume that adult animals usually return to their spawning site every year. Additionally, transience between spawning waters — even over a long time period — seems to be rare and the adult amphibians reveal a high spawning fidelity (cf. Kneitz, 1997). Taking into account that capture probability with the applied methods does not reach 100% the true survival rates are definitely higher than our observed return rates. In consequence one can equate return rates at least with minimum survival rates.

Common frog and great crested newt show a similar return rate of about 20% from one year to another. Compared to literature these data are extremely low for both species: especially for *Triturus cristatus*, which is considered as a k-strategist, published annual return rates range between 31 and 100% and thus are at least 10% higher than in our results (summary in Arntzen and Teunis, 1993; Baker, 1999). Because our population in the same period was expanding constantly, this indicates a relatively high recruitment rate but disadvantageous adult survival conditions. That idea is supported by the remarkable low body sizes of the adults compared to literature, which suggests an age structure of the population with a high proportion of young animals (Ortmann, unpublished).

Similarly, return rates of *Rana temporaria* are at the lower end of published data, for example Ryser (1986) and Gibbons and McCarthy (1984) with return rates ranging from 36 to 50%. Otherwise Elmberg (1990) shows similar average annual return rates of 31% for males (min. 16%, max. 51%) and 16% for females (min. 5%, max. 33%). It

**TABLE 3.** Recaptured *Triturus cristatus* from the Period 1993 – 1997

| Number of specimens | Sex | First observation as adult | Year(s) of recapture | Age at last capture, years | Recapture place |
|---|---|---|---|---|---|
| 1 | ♀ | 1995 | 2001 – 2003 | 10 | same pond |
| 1 | ♀ | 1997 | 2001 | 8 | same pond |
| 1 | ♂ | 1995 | 2001, 2002 | 8 | same pond |

is likely that those data differ from population to population depending on climate, structures of spawning and terrestrial habitats.

Exceptionally the agile frog shows a high return probability of about 50%, which was in the years 2000 – 2003 nearly similar to those of the former project phase (Kneitz, 1997). Depending on year, pond and sex Kneitz (1997) acquired rates between 21% and 53% in the same ponds 8 – 10 years earlier. These data indicate good survival conditions for adult agile frogs in our study area.

Only in *Rana dalmatina* we found statistically significant differences between sexes concerning return probability. Because Kneitz (1997) as well had continuous lower return rates of females in all ponds and both study years (1993, 1994) this result seems to be valid for a long time at least in our pond system. In contrast no differences between sexes occur for *R. temporaria* and *T. cristatus*. Baker (1999) indicates no sex-specific differences for *Triturus cristatus*, as well as Gibbons and McCarthy (1984) and Elmberg (1990) for *Rana temporaria*. Thus, similar return rates of both sexes seem to be a frequent phenomenon for these species.

### Long-Term Capture Histories

Individual recognition by transponders, toe-clipping, and photo identification, applied over a long period, enables us to determine minimum ages of long-lived individuals in the field. Observed ages belong to the highest recorded in field studies in Europe. Those old individuals show that at least a few specimens can reach very high ages in the field and they are still able to take part in reproduction regularly. They also suggest a high pond fidelity for many years. In most cases hatching pond and spawning water are identical.

Compared with return rates over three years (Figs. 1 – 3) mortality of old animals seems to be much lower than that of younger. This suggests at least two different strategies: The bigger part of a population spawns only a few times, but a minority group of few individuals takes part in reproduction over many years. Baker (1999) as well demonstrates for *Triturus cristatus*, that young individuals experience significant lower survival than older newts. Elmberg (1990) shows for *Rana temporaria* that return rates increase with every successful previous hibernation, which indicates an increasing survival rate with age. Especially these old specimens might be important for maintenance of populations under temporary bad habitat conditions for reproduction and periods with low recruitment rates (e.g., pond drying, cf. Baker, 1999).

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