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Minnow traps from North America as tools for monitoring amphibians – first results from European newt populations

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Zusammenfassung

Kleinfischreusen aus Nordamerika als Hilfsmittel beim Amphibienmonitoring – erste Ergebnisse aus europäischen Molchpopulationen

Ein wichtiges Ziel im Naturschutz ist die Standardisierung der nationalen Monitoringprogramme, um die Vorgaben der europäischen FFH-Richtlinie zu erfüllen. Um Amphibien, besonders Molche, in einer standardisierten Form zu erfassen, setzt sich zunehmend der Fang mit sogenannten Trichterfallen durch. Mittlerweile ist in Europa eine Vielzahl von Fallentypen im Einsatz, die alle Vor- und Nachteile haben. Deshalb testeten wir erstmalig in Europa mit den Kleinfischfallen (minnow traps) ein anderes Sortiment von Fallen, die in Nordamerika weit verbreitet sind. Ursprünglich wurden sie konstruiert, um kleine Fische damit zu fangen. Jedoch werden sie schon seit längerer Zeit bei Untersuchungen mit Amphibien genutzt. Wir präsentieren erste, vorläufige Ergebnisse einer Studie, die fortgeführt wird.

Die Untersuchung wurde in drei Gebieten in Westfalen in Nordwestdeutschland durchgeführt. Insgesamt, aber nicht an allen Untersuchungsorten, kommen vier Molcharten in der Region vor: *Lissotriton vulgaris* (Teichmolch), *L. helveticus* (Fadenmolch), *Ichthyosaura alpestris* (Bergmolch) und *Triturus cristatus* (Kammmolch).

Wir testeten verschiedene Typen von Kleinfischreusen und zum Vergleich zwei weitere Fallen, eine zusammenfaltbare Kleinfischreuse aus Netzmaterial und die sogenannte Henf-Falle, die in Deutschland häufig eingesetzt werden. Zwei Kleinfischreusentypen wurden auch unter Laborbedingungen in Aquarien getestet.

Insgesamt wurden 1174 Molche in der Saison 2012 gefangen. Als beste Fallentypen zum Fang adulter Molche erwiesen sich die Kleinfischreuse „Gee 40" in einer optimierten Version und die Henf-Falle. Sie fingen vor allem große Anzahlen von *Lissotriton vulgaris* und *Ichthyosaura alpestris* sowie hinreichende Anzahlen von *Triturus cristatus*. Mit der Kleinfischreuse „Gee 48" konnten auch hinreichend große Anzahlen der beiden erstgenannten Molcharten gefangen werden, jedoch nur wenige der letztgenannten Art. Die Kleinfischreuse „Plastik" erbrachte nur geringe Anzahlen der kleineren Molcharten (*Lissotriton, Ichthyosaura*), wohingegen die große Art *Triturus cristatus* damit etwas besser gefan-

gen wurde. Die zusammenfaltbare Kleinfischreuse erwies sich als schlecht geeignet zum Fang von Molchen.

Die ersten Ergebnisse lassen erkennen, dass einige Typen der Kleinfischreusen aufgrund der geringen Fängigkeit oder aus Tierschutzgründen nicht brauchbar für unsere Zwecke sind. Weitere Untersuchungen müssen mehr Daten zu verschiedenen Aspekten bringen, z. B. zu art- oder geschlechtsspezifischen Effekten, zur Bedeutung der Maschenweite und Wassertemperatur sowie zu wirbellosen Prädatoren, die einen Einfluss auf die Fangergebnisse der Amphibien haben könnten.

Summary

An important aim in the context of biological conservation is the standardization of national monitoring programmes to fulfill the demands of the Habitat Directive of the European Community. For monitoring amphibians, especially newts, in a standardized manner an increasingly used method is to catch them in funnel traps. Meanwhile in central Europe numerous types of traps are used, which all have advantages as well as disadvantages. Therefore we tested minnow traps, which are widely used in North America, for the first time in Europe. Although originally constructed to catch small fishes, they have been also used to study amphibians for a long time. Here we present preliminary results of a study which is on going.

The investigation was conducted at three sites in Westphalia, North West Germany. Four newt species can be found in the region, but not at all sites: *Lissotriton vulgaris* (Smooth Newt), *L. helveticus* (Palmate Newt), *Ichthyosaura alpestris* (Alpine Newt) and *Triturus cristatus* (Great Crested Newt).

We tested several types of minnow traps and for comparison two other traps which are often used in Germany, a collapsible nylon trap and the so-called HENF trap. Two types of minnow traps were also tested in laboratory aquaria. A total of 1174 newt catches were obtained in 2012. An optimized version of the Minnow trap “Gee 40” and the HENF trap were the best types for catching adult newts. They caught especially high numbers of *Lissotriton vulgaris* and *Ichthyosaura alpestris* and sufficient numbers of *Triturus cristatus*. The minnow trap “Gee 48” also yielded sufficient numbers of the first two species but only small numbers of the latter. With the minnow trap “plastic” only small numbers of the small newt species (*Lissotriton*, *Ichthyosaura*) were obtained, whereas the large species (*Triturus cristatus*) were better captured. The collapsible nylon trap was of low efficiency for catching newts.

As a preliminary conclusion some types of minnow traps were not suitable for our purpose due to low catchability or from the view of animal welfare. Further investigations should yield more data about different aspects, e. g. species and sex specific effects, the significance of the mesh width and water temperature, as well as predatory invertebrates as enemies of the caught amphibians.

Introduction

Amphibian decline has forced the monitoring of populations in order to get exact and comparable long term data. But this has become a difficult task due to the diverse groups of amphibians (e. g. frogs, newts, adults, larvae) as well as very different situations in the field (e. g. shallow and deep waters, small and large waters, terrestrial and aquatic habitats). A lot of different methods have been developed recently and preferred methods are being established (for recent reviews see SCHLÜPMANN & KUPFER 2009; WILLSON & GIBBONS 2010; GLANDT 2011, 2014). While anuran species can often be monitored by documenting calling males or by counting egg masses, monitoring of newts (genera *Lissotriton*, *Triturus*, *Ichthyosaura* and others) is a difficult task. By convention monitoring takes place during breeding time, when newts live in water. For a long time they were counted during migration to breeding sites by using drift fences, which completely surrounded the breeding waters (WILLSON & GIBBONS 2010). But drift fences often cannot be installed due to problems in the field (too large a water habitat, problems with land owners, etc.), they are expensive, and the control of the pitfall traps combined with the fences needs a lot of manpower and time. Furthermore recent studies revealed them as strong barriers for migrating newts which negatively influence their behaviour (ORTMANN et al. 2005, SANDER et al. 2006). Furthermore the benefit is not as high as often assumed (WEDDELING et al. 2004). Increasingly, different types of funnel traps placed in the breeding waters are therefore being used as tools for monitoring amphibians. They all have advantages on one hand, but several problems on the other (HAACKS et al. 2009, SCHLÜPMANN 2009, DRECHSLER et al. 2010, KRÖPFLI et al. 2010, GLANDT 2011, 2014).

An important aim in the context of biological conservation is the standardization for national monitoring programmes to fulfill the demands of the EC Habitat Directive (Council Directive 92/43/EEC). Therefore it would be very important to receive an agreement between the field herpetologists and the authorities of biological conservation with respect to a unique monitoring method. This goal is also true for newts, especially the Great Crested Newt (*Triturus cristatus*), which is listed in annex II of the directive and declining at least in Western Europe (DENOËL 2012).

In North America different types of minnow traps are widely used as underwater amphibian traps (ADAMS et al. 1997, WILLSON & GIBBONS 2010). These traps have to our knowledge not been used in Europe so far. In the western part of North America aquatic urodeles are rather large with a great body diameter (e. g. *Taricha* and *Ambystoma* species). Most European newts (with exception of the Crested Newt group, genus *Triturus* in modern taxonomical sense, see GLANDT 2010), however, are comparably small and thin animals. It was therefore interesting for us to test minnow traps in European newt waters.

Here we present our preliminary data and conclusions. The study is on going and should answer the question whether minnow traps are more efficient than other types of traps used so far in Europe.

Materials and methods

Minnow traps are not available from dealers in Europe. Therefore we ordered several types in USA and thus had to pay customs duty, adding to the cost of the study.

An important point for us to test with minnow traps is that they are porous. Water can easily pass through the trap even in standing waters and therefore overheating of animals in late afternoon may be prevented. Oxygen supply would probably be better in these traps, than in those which are not porous (GLANDT 2014). This attribute favours amphibian larvae as well as metamorphosed amphibians, the latter in particular due to some cutaneous respiration. Furthermore captured newts are able to climb up the wall using the meshes of the trap in order to get atmospheric oxygen.

In 2011 we tested seven types of funnel traps (figure 1, table 1). All have two outer openings, so we concluded that data are comparable between the types. In 2012 we conducted the investigation using only five types because two had not been suitable for our purpose. The minnow trap "Cuba" has too large a mesh for catching the small newts (*Lissotriton*, *Ichthyosaura*). Furthermore it has not been galvanized, so the wire can rust. The minnow trap "Gee 40" also has a wide mesh. More important, the wire is too sharp and the inner openings are pointed allowing newts to be injured. But this type was used in an optimized version ("Gee 40 opt.", table 1), by coating the traps with a heated fluid of plastic (Rilsan). After cooling, the traps had a plastic coat which prevented injuring of animals. Furthermore this procedure resulted in a little smaller mesh width. Before using the minnow trap "Gee 48" it is necessary to treat the inner opening and joint with hot glue to avoid injury to the newts caused by the sharp wire ends. The collapsible nylon trap in its original form is not suitable for catching amphibians. It is necessary to construct funnel-like openings by pulling the openings on both sides into the trap with a nylon string. Plastic floaters fixed at the top of the trap prevent sinking under water and ensure a reservoir of atmospheric oxygen. The HENF trap was tested as the widely used model I. Meanwhile a modified type "HENF LAAR trap" (model II) is available (see GLANDT 2014).

Traps were placed in late afternoon at the shallow shore regions of the ponds, and checked the following morning. After documentation, all animals (newts, sometime frogs, often invertebrates) were released. Air and water temperature were measured, and weather conditions were noted. At three ponds traps were set five times, at one pond two times and at two ponds only once. For trapping dates see table 2.

For statistical analyses chi-square tests were made with a minimum level of significance of $p < 0,05$ (see HEDDERICH & SACHS 2012).

Figure 1: The seven types of funnel traps tested: (a) Minnow trap plastic, (b) Minnow trap “Cuba”, (c) Minnow trap “Gee 40”, (d) Minnow trap “Gee 40 optimized”, (e) Minnow trap “Gee 48”, (f) HENF trap (model I, a modified model II HENF-LAAR is now available), (g) Collapsible nylon trap. Photos: A. Kronshage.

Abb. 1: Die getesteten sieben Trichterfallen: a) Kleinfischreuse „Plastik“, b) Kleinfischreuse „Cuba“, c) Kleinfischreuse „Gee 40“, d) Kleinfischreuse „Gee 40 optimiert“, e) Kleinfischreuse „Gee 48“, (f) HENF-Falle (Kastenreuse, erstes Modell, erhältlich ist mittlerweile ein modifiziertes zweites Modell HENF-LAAR), g) zusammenfaltbare Kleinfischreuse.

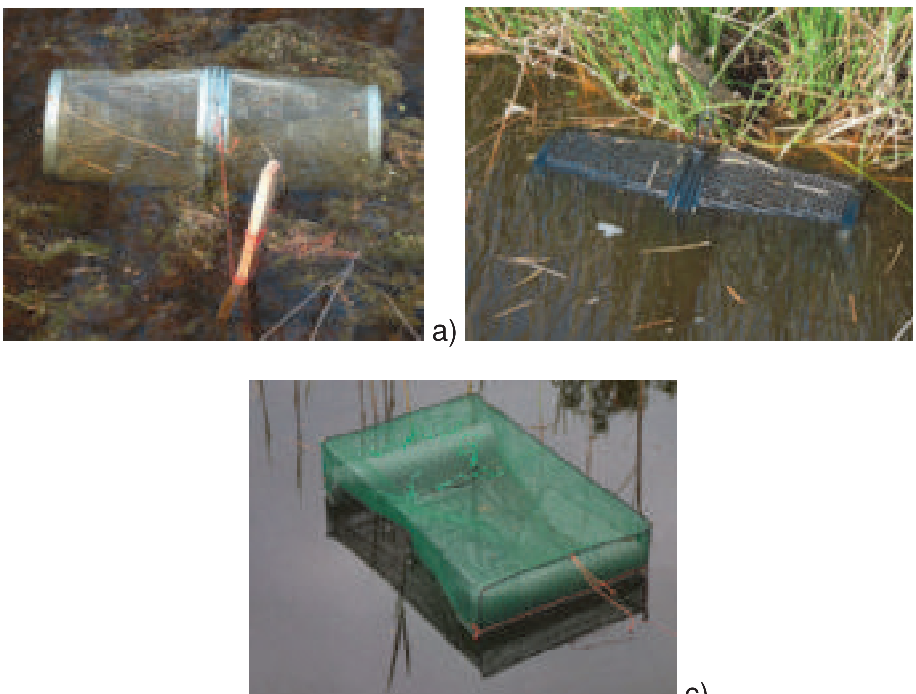
Table 1: Characteristics of the types of funnel traps which were used in the study. For the two columns "assessment" see chapter "discussion" (red = not suitable for trapping amphibans, yellow = not optimal for trapping amphibians, green = well suitable for trapping amphibians).

Tab. 1: Merkmale der in der Untersuchung eingesetzten Trichterfallen. Zu den beiden Spalten „Bewertung" siehe Kapitel Diskussion (rot = nicht verwendbar zum Fang von Amphibien, gelb = nicht optimal zum Fang von Amphibien, grün = gut verwendbar zum Fang von Amphibien).

Type of trap	**Assessment (protection of animals)**	**Assessment (catchability)**	**Material**	**Colour**	**Length [cm]**	**Width [cm]**	**Diameter of outer opening [cm]**	**Diameter of inner opening [cm]**	**Width of meshes [mm]**	**Problems**	**Cost per trap [Euro]**
Minnow trap "Plastic"			plastic	white	42	23,5	11	2	7 x 7, 6 x 3, and others *	varying mesh width, partly too large	about 6
Minnow trap "Cuba"			painted metal	black	43	22,5	17,5	3	rhombic meshes, 6 x 6, diago-nally 11	meshes too wide, rust, does not close well	about 4
Minnow trap "Gee 40" (G40)			galvanized metal	silvery	42	22,5	19	2	6 x 6	meshes too wide, wire sharp	about 15
Minnow trap "Gee 40 opt." (G40 opt)	*to be optimized further-more*		galvanized metal, coated with plastic (Rilsan)	black	42	22,5	19	2	5 x 5	meshes too wide for small newts	about 15, in addition 20 for optimizing
Minnow trap "Gee 48" (G48)			galvanized metal	silvery	42	22,5	19	2	3 x 3	inner opening and join to be dealt with hot glue	about 25
HENF trap, model I	*not optimal*		plastic mesh hardware-cloth	green	50	30	19 x 19	4 x 4	4 x 4	caught animals difficult to get out, especially tadpoles	about 23
Collapsible nylon trap			net	green	about 53	23	23 x 23	7	4 x 3	inner opening too wide, poor quality of material (zipper, net)	about 5

* other width of meshes [mm] such as 7 x 5, 6 x 6, 6 x 4

All traps were placed into the ponds in a position which allowed the captured amphibians and air breathing invertebrates to get atmospheric oxygen (figure 2). They were placed in groups, each consisting of five traps. The distances between the traps within a group measured between one and three meters. The sequence was the same in each group: HENF trap, three types of minnow traps ("Gee 40 opt.", plastic, "Gee 48") and collapsible nylon trap. Three groups per pond were positioned at different shore sections, if possible in an equal distance from each other. No trap was baited (compare ADAMS et al. 1997). All traps were fixed by a string and stick on the shore so they could not drift away and the minnow traps without floaters could not sink under water, respectively. Due to the wooden sticks they could be detected easily (see fig. 2a). The minnow traps lay on the ground near the shore in free water zones, next to vegetation or within submerged vegetation. They contained at the top an atmospheric oxygen reservoir (figure 2) and were not set completely under water.



a) b) c)

Figure 2: Three types of exposed funnel traps: (a) Minnow trap "Gee 48", lying on the ground at the shore of a shallow pond. (b) Minnow trap "Gee 40 opt.", fixed by a string and a stick somewhat above the water surface in front of a belt of rushes of a deeper pond. (c) HENF trap, swimming with two plastic floaters at the water surface in a deeper part of a pond. Photos: D. Glandt (a, b), A. Kronshage (c).

Abb. 2: Drei Typen ausgelegter Trichterfallen: a) Kleinfischreuse „Gee 48" im Uferbereich auf dem Boden eines flachen Gewässers liegend. b) Kleinfischreuse „Gee 40 opt." mit einer Schnur und einem Stab etwas oberhalb der Wasseroberfläche befestigt vor einem Binsengürtel in einem tieferen Gewässer. c) HENF-Falle mit zwei Schwimmern aus Plastik an der Oberfläche in einem tieferen Gewässerteil schwimmend.

Table 2: Trapping data, temperature and weather conditions (n. m.: not measured, * Air °C measured at 2:00 p.m. at the first-mentioned day, °C data for the ponds "Hopsten" derived from meteorological station Heiliges Meer / Recke).

Tab. 2: Datum der Fallennächte, Temperaturen und Wetterbedingungen (n. m.: nicht gemessen, * Angabe Luft °C gemessen um 14 Uhr am erstgenannten Tag, °C-Daten für die Gewässer „Hopsten" stammen von der Meteorologischen Station Heiliges Meer / Recke).

Location and studied water	**Date 2012**	**°C Air, Time**	**°C Water, Time**	**Weather conditions and °C Air at 2:00 p.m. on the first-mentioned day ***
Hopsten HM 1 (Nature reserve Hl. Meer, heath pond, left)	26.3. / 27.3.	15°C, 7:00 p.m. / 3°C, 8:00 a.m.	n. m. / n. m.	cold nights, 10 °C
	17.4. / 18.4.	10°C, 8:00 p.m. / 8°C, 9:00 a.m.	6°C, 8:00 p.m. / 6°C, 9:00 a.m.	cold nights and days, 10°C
	24.4. / 25.4.	9°C, 8:30 p.m. / 12°C, 10:00 a.m.	10°C, 8:30 p.m. / 10°C, 10:00 a.m.	13 °C
	2.5. / 3.5.	18°C, 8:30 p.m. / 11°C, 7:30 a.m.	17°C, 8:30 p.m. / 14°C, 7:30 a.m.	since about one week warm, sunny, 23 °C
	21.5. / 22.5.	19°C, 9:00 p.m. / 12°C, 7:00 a.m.	20°C, 9:00 p.m. / 16°C, 7:00 a.m.	warm, 25 °C
Hopsten HM 2 (Nature reserve Hl. Meer, Erdfallpond)	28.3. / 29.3.	20°C, 7:00 p.m. / 3°C, 8:00 a.m.	n. m. / n. m.	cold nights, 19 °C
	16.4. / 17.4.	3°C, 8:00 p.m. / 1°C, 8:00 a.m.	9°C, 8:00 p.m. / 10°C, 11:30 a.m.	cold nights and days, 8 °C
	23.4. / 24.4.	11°C, 8:00 p.m. / 10°C, 8:30 a.m.	10°C, 8:00 p.m. / 9°C, 8:30 a.m.	12 °C
	4.5. / 5.5.	19°C, 6:00 p.m. / 10°C, 11:00 a.m.	13°C, 6:00 p.m. / 14°C, 11:00 a.m.	warm, 20 °C, cooling at 5.5.
	22.5. / 23.5.	26°C, 8:00 p.m. / 15°C, 6:30 a.m.	25°C, 8:00 p.m. / 20°C, 6:30 a.m.	warm, 28 °C
Hopsten HM 3 (Nature reserve Hl. Meer, Üffing pond)	27.3. / 28.3.	12°C, 7:00 p.m. / 3°C, 8:00 a.m.	n. m. / n. m.	cold nights, 17 °C
	19.4. / 20.4.	9°C, 8:00 p.m. / 7°C, 8:30 a.m.	12°C, 8:00 p.m. / 12°C, 8:30 a.m.	cold nights and days, 12 °C
	25.4. / 26.4.	9°C, 8:30 p.m. / 9°C, 7:30 a.m.	10°C, 8:30 p.m. / 9°C, 7:30 a.m.	14 °C
	5.5. / 6.5.	5°C, 8:00 p.m. / 3°C, 9:00 a.m.	13°C, 8:00 p.m. / 10°C, 9:00 a.m.	cooling at 5.5., 12 °C; great differences in air and water °C
	23.5. / 24.5.	28°C, 4:30 p.m. / 14°C, 6:30 a.m.	30°C, 4:30 p.m. / 19°C, 6:30 a.m.	warm, 29 °C
Münster (Coerheide, crossroads)	18.4. / 19.4.	6°C, 8:30 p.m. / 5°C, 6:30 a.m.	9°C / 8:30 p.m. / 7°C, 6:30 a.m.	cold during day and night, 14 °C
	24.5. / 25.5.	18°C, 9:00 p.m. / 19°C, 10:30 a.m.	22°C, 9:00 p.m. / 18°C, 10:30 a.m.	warm, 26 °C
Schwelm 1 (Wolfsbecke, a damed up spring)	26.5. / 27.5.	19°C, 9:00 p.m. / 10°C, 6:00 a.m.	15°C, 9:00 p.m. / 12°C, 6:00 a.m.	warm, 24 °C
Schwelm 2 (Böllingweg)	25.5. / 26.5.	19°C, 8:00 p.m. / 12°C, 7:30 a.m.	21°C, 8:00 p.m. / 18°C, 7:30 a.m.	warm, 24 °C

Test of minnow traps in laboratory aquaria

The width of trap mesh is variable (table 1). If meshes are too wide it could happen that very small and thin adult specimens of Palmate or Smooth Newts can press or slip through or become stuck in the mesh. This was observed with the minnow trap „plastic“ with different width of meshes and with the minnow trap „Gee 40 optimized“ (figure 3).

We observed mesh size effectiveness with tests in two aquaria. Seven to fourteen of the smallest Palmate or Smooth Newts caught in a pond were put in a minnow trap with closed openings on both sides. The openings were closed with a plastic stopper and the minnow trap was partially submerged in the aquaria so the newts could get atmospheric oxygen (figure 4). We observed how much newts slipped through the mesh and how long they stayed within the trap. The duration of the tests varied from ten minutes to nearly thirty-six hours. Within the duration of a test the funnel traps were controlled in irregular periods of time. Some very small and thin newts slipped through the mesh after a short time, some other newts stayed for a longer time within the minnow trap or do not leave the minnow trap during the whole test duration (table 3).

Figure 3: A very small adult Palmate Newt male tries to slip through the mesh of a minnow trap "plastic". Photo: A. Kronshage

Abb. 3: Das Männchen eines sehr dünnen Fadenmolches versucht durch das Gitter einer Kleinfischreuse (Typ "Plastik") zu entkommen.

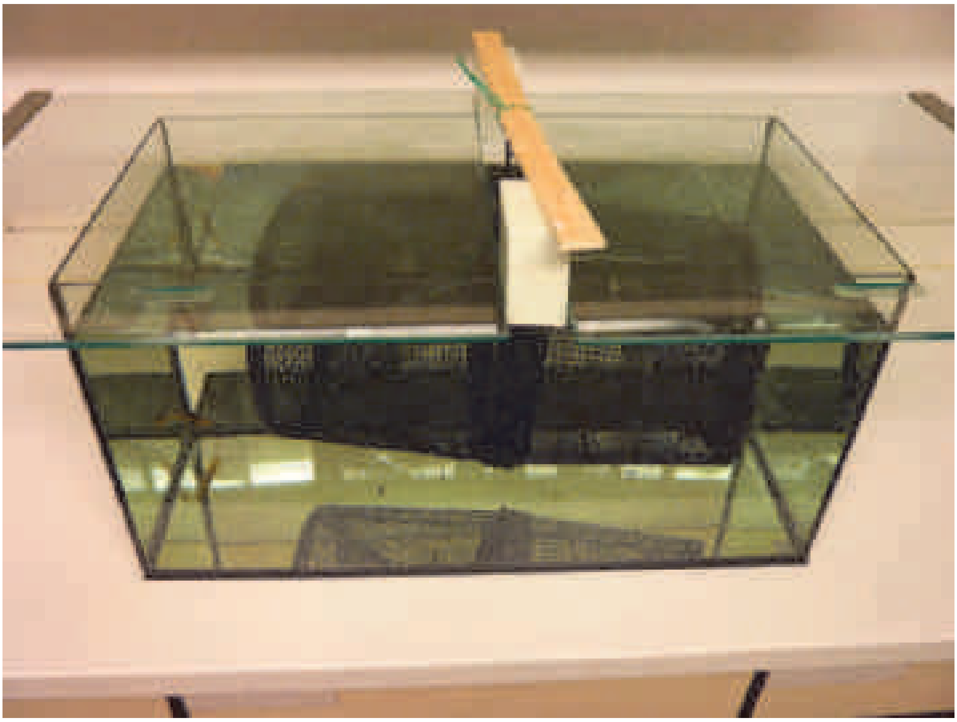


Figure 4: Very small and thin adult specimens of newts were tested in minnow traps with closed openings in laboratory aquaria (here: minnow trap "Gee 40 opt." with Palmate and Smooth Newts). Photo: A. Kronshage

Abb. 4: In Laboraquarien wurden in Kleinfischreusen mit verschlossenen Öffnungen sehr kleine und schmale adulte Molche getestet (in der Abbildung Kleinfischreuse „Gee 40 opt." mit Faden- und Teichmolchen).

(next page)

Table 3: Minnow traps with newts inside tested in laboratory aquaria.
+ : Number of newts stocked at the beginning of the test into the funnel trap
- : Number of newts outside the funnel trap at the end of the test
f +: Number of newts inside the funnel trap at the end of the test
uc: Unchanged number
* : Only the smallest newts which escaped from the minnow trap „plastic" from the previous test were now stocked in the minnow trap "Gee 40opt".

Tab. 3: In Laboraquarien getestete Kleinfischreusen mit Molchen, die vor Versuchsbeginn in die Reusen eingesetzt wurden.
+ : Anzahl der Molche, die zu Versuchsbeginn in die Trichterfalle eingesetzt wurden.
- : Anzahl der Molche, die sich zum Versuchsende außerhalb der Trichterfalle befanden.
f +: Anzahl der Molche, die zum Versuchsende in der Trichterfalle verblieben.
uc: unveränderte Anzahl
* : Nur die kleinsten Molche, die im vorherigen Versuch aus der Kleinfischreuse „Plastik" entkamen, wurden jetzt in die Kleinfischreuse „Gee 40opt" eingesetzt.

Funnel trap type	Date 2012	Time	Test duration [Td hours: minutes]	*Lissotriton vulgaris* ♂	*Lissotriton vulgaris* ♀	*Lissotriton helveticus* ♂	*Lissotriton helveticus* ♀
Minnow trap Plastic	17.4.	6:45 p.m.	start	+ 5	+ 3		
		6:49 p.m.		- 1	uc		
		6:51 p.m.		- 1	uc		
		6:55 p.m.		- 1	uc		
	18.4.	7:30 a.m.	end: Td 12:45	- 3 (f + 2)	- 3 (f 0)		
Gee 40opt	18.4.	7:45 a.m.	start	+ 5	+ 3		
		7:46 a.m.		- 1	uc		
		7:56 a.m.		- 1	uc		
	18.4.	5:30 p.m.	end: Td 9:45	-3 (f + 2)	- 1 (f + 2)		
Gee 40opt	18.4.	6:00 p.m.	start	+ 5	+ 3		
		6:02 p.m.		- 1	uc		
		6:07 p.m.		- 1	uc		
	18.4.	6:10 p.m.	end: Td 0:10	- 2 (f + 3)	uc (f + 3)		
Minnow trap Plastic	11.5.	1:15 a.m.	start			+ 9	+ 5
		1:18 a.m.				uc	- 1
		2:50 a.m.				- 2	- 2
		7:15 a.m.				- 3	- 1
	11.5.	7:20 a.m.	end: Td 06:05			- 5 (f + 4)	- 4 (f + 1)
Gee 40opt	11.5.	7:30 a.m.	start			+ 9	+ 5
		10:00 a.m.				uc	uc
		1:00 p.m.				uc	uc
		8:00 p.m.				uc	uc
	12.5.	7:30 a.m.				uc	uc
	12.5.	7:00 p.m.	end: Td 35:30			uc (f + 9)	uc (f + 5)
Minnow trap Plastic	12.5.	7:10 p.m.	start			+ 9	+ 5
		7:14 p.m.				- 2	uc
		7:21 p.m.				- 1	uc
		8:15 p.m.				uc	- 1
	12.5.	10:30 p.m.	end: Td 03:20			- 5 (f + 4)	- 2 (f + 3)
Gee 40opt	12.5.	10:45 p.m.	start			+ 5 *	+ 2 *
	13.5.	2:00 a.m.				uc	uc
		7:00 a.m.				uc	uc
	13.5.	6:00 p.m.	end: Td 19:15			uc (f + 5)	uc (f + 2)

Geographic position and characteristics of the surveyed ponds

The six ponds studied are situated in lowland and highland regions of North Rhine-Westphalia (Germany) at altitudes between 43 and 330 m above sea level (a. s. l.) (figure 5, figure 6) and surfaces between 80 and 2250 m². The ponds are situated in nature reserves, protected landscape areas or near the edge of a settlement (Schwelm 2). Details about the ponds are given in table 4.

Figure 5: Geographic position of the surveyed ponds in North Rhine-Westphalia, Germany. Scale for North Rhine-Westphalia: The distance from southwest to northeast is approximately 300 kilometres.

Abb. 5: Lage der untersuchten Gewässer im Bundesland Nordrhein-Westfalen, Deutschland. Maßstab für Nordrhein-Westfalen: Die Entfernung vom Südwesten zum Nordosten beträgt ungefähr 300 Kilometer.


a)


b)

c)

d)

e)

f)

Figure 6: The ponds surveyed in the trapping season 2012. a) Hopsten, HM 1, with exposed traps at the shore, b) Hopsten, HM 2, c) Hopsten, HM 3, d) Münster, e) Schwelm 1, f) Schwelm 2. Photos: A. Kronshage.

Abb. 6: Die untersuchten Gewässer in der Fallensaison 2012: a) Hopsten, HM 1, mit exponierten Fallen in Ufernähe, b) Hopsten, HM 2, c) Hopsten, HM 3, d) Münster, e) Schwelm 1, f) Schwelm 2.

Table 4: Basic characteristics of the surveyed ponds.
Tab. 4: Charakterisierung der Untersuchungsgewässer.

Studied water	Newt species	Water type	Surface area [qm]	Measure-ment [m]	Depth [m]
Hopsten HM 1	*Ichthyosaura alpestris, Lissotriton vulgaris*	small pond (pool)	154	14 m in diameter	< 1,00
Hopsten HM 2	*Ichthyosaura alpestris, Lissotriton vulgaris*	pond	1385	42 m in diameter	about 1,20
Hopsten HM 3	*Ichthyosaura alpestris, Lissotriton vulgaris*	pond with mainly shallow zones	2250	30 x 75	mainly about 0,80-1,00; partly up to 1,50
Münster	*Ichthyosaura alpestris, Lissotriton vulgaris, Triturus cristatus*	pond	250	25 x 10	up to 1,50
Schwelm 1	*Ichthyosaura alpestris, Lissotriton vulgaris, Lissotriton helveticus, Triturus cristatus*	damed up spring	80	9 x 9	up to 1,00
Schwelm 2	*Ichthyosaura alpestris, Lissotriton vulgaris, Lissotriton helveticus*	pond	1320	about 40 x 33	up to 1,50

Insolation	Vegetation	Altitude a.s.l.	Natural geographic region	Other aspects
partly shaded	sparse vegetation	43	Westphalian Lowland	mainly leaf litter, since 2010 expansion of water hose (*Utricularia*)
sun exposed	rich vegetation	43	Westphalian Lowland	rich of water lily (*Nymphaea*), on the bank mainly rush (*Juncus*)
sun exposed	rich vegetation	43	Westphalian Lowland	renaturation and desludging in August 2011, young reed (*Phragmites*) spread out, low in submerged vegetation, sinking water-level requires placement of traps far from the bank area in May
sun exposed	very rich vegetation	53	Münsterland region (lowland)	sinking water-level mainly in May
partly shaded	rich vegetation	330	South-Westphalian Highland	many reed sweet-grass (*Glyceria*) and pondweed (*Potamogeton*), pond with spring water at the beginning of a valley, ditch cleaning in 2006
sun exposed	very rich vegetation	210	South-Westphalian Highland	formerly used as an artficial water reservoir, renaturated in 1997

Results

No study animal was marked or identified by individual pattern. Therefore the data show mean catches and not individual specimens. A total of 1153 adult captures of the four newt species and 21 subadult captures of the Great Crested Newt were obtained in the trapping season 2012 (table 5). *Lissotriton vulgaris* and *Ichthyosaura alpestris* captures dominated, followed by *Triturus cristatus* and *Lissotriton helveticus* (figure 7a-d).

Table 5: Captures of newts in 2012. ♂ = male, ♀ = female, sad = subadult, N = number.
Tab. 5: Molchfänge in 2012 (♂ = Männchen, ♀ = Weibchen, sad = subadult, N = Anzahl).

		Lissotriton vulgaris			***Lissotriton helveticus***		
Type of trap	**Pond**	♂	♀	N	♂	♀	N
HENF trap	Hopsten HM 1	17	7	24			
	Hopsten HM 2	16	16	32			
	Hopsten HM 3	4	11	15			
	Münster	8	3	11			
	Schwelm 1	11	7	18	10	11	21
	Schwelm 2	36	10	46	2	2	4
	Total number	92	54	146	12	13	25
Minnow trap "Gee 40 opt."	Hopsten HM 1	8	6	14			
	Hopsten HM 2	50	19	69			
	Hopsten HM 3	0	5	5			
	Münster	16	13	29			
	Schwelm 1	5	3	8	3	3	6
	Schwelm 2	61	44	105	0	3	3
	Total number	140	90	230	3	6	9
Minnow trap "Plastic"	Hopsten HM 1	0	0	0			
	Hopsten HM 2	0	0	0			
	Hopsten HM 3	0	0	0			
	Münster	0	0	0			
	Schwelm 1	0	0	0	0	0	0
	Schwelm 2	4	0	4	0	0	0
	Total number	4	0	4	0	0	0
Minnow trap "Gee 48"	Hopsten HM 1	12	5	17			
	Hopsten HM 2	12	9	21			
	Hopsten HM 3	3	5	8			
	Münster	13	3	16			
	Schwelm 1	1	6	7	3	1	4
	Schwelm 2	38	19	57	0	0	0
	Total number	79	47	126	3	1	4
Collapsible nylon trap	Hopsten HM 1	3	1	4			
	Hopsten HM 2	5	1	6			
	Hopsten HM 3	1	1	2			
	Münster	0	1	1			
	Schwelm 1	0	4	4	1	2	3
	Schwelm 2	3	2	5	0	0	0
	Total number	12	10	22	1	2	3
Total number				**528**			**41**

Ichthyosaura alpestris			***Triturus cristatus***				**Total number**			
♂	♀	N	♂	♀	sad	N	♂	♀	sad	N
33	22	55					50	29		79
3	7	10					19	23		42
1	21	22					5	32		37
4	13	17	8	14	10	32	20	30	10	60
6	7	13	5	3	2	10	32	28	2	62
11	15	26					49	27		76
58	85	143	13	17	12	42	175	169	12	356
27	24	51					35	30		65
16	6	22					66	25		91
1	9	10					1	14		15
5	4	9	14	16	4	34	35	33	4	72
6	6	12	7	4	0	11	21	16		37
15	18	33					76	65		141
70	67	137	21	20	4	45	234	183	4	421
4	9	13					4	9		13
2	1	3					2	1		3
0	2	2					0	2		2
0	0	0	8	7	0	15	8	7	0	15
0	2	2	0	0	1	1	0	2	1	3
0	14	14					4	14		18
6	28	34	8	7	1	16	18	35	1	54
11	12	23					23	17		40
3	3	6					15	12		27
2	10	12					5	15		20
6	4	10	4	10	3	17	23	17	3	43
8	8	16	2	3	0	5	14	18	0	32
35	42	77					73	61		134
65	79	144	6	13	3	22	153	140	3	296
6	2	8					9	3		12
0	2	2					5	3		8
0	2	2					1	3		4
0	0	0	1	4	1	6	1	5	1	7
0	2	2	0	1		1	1	9		10
0	1	1					3	3		6
6	9	15	1	5	1	7	20	26	1	47
		473				**132**				**1174**

a)

b)

c)

d)

Figure 7a-d: Males of the four middle European newt species in breeding condition: a) Great Crested Newt (*Triturus cristatus*), b) Alpine Newt (*Ichthyosaura alpestris*), c) Smooth Newt (*Lissotriton vulgaris*), d) Palmate Newt (*Lissotriton helveticus*). Photos: B. Trapp.

Abb. 7a-d: Männchen der vier mitteleuropäischen Molcharten zur Paarungszeit: a) Kammmolch (*Triturus cristatus*), b) Bergmolch (*Ichthyosaura alpestris*), c) Teichmolch (*Lissotriton vulgaris*), d) Fadenmolch (*Lissotriton helveticus*).

Most captures were obtained by the minnow trap “Gee 40 opt.”, by HENF trap and by minnow trap “Gee 48”. On the assumption that the two first traps should catch newts with equal probability there is no significant difference (P>0,05, chi-square test), but between “Gee 40 opt.” and “Gee 48” the difference is highly significant (P<0,001).

Minnow trap plastic revealed only a few captures, mostly *T. cristatus* and females of *I. alpestris*. The collapsible nylon trap revealed the lowest number of captures (table 5).

As an example table 6 illustrates the different capture success of funnel traps used in our study for one trapping night in the surveyed pond Schwelm 2. In this pond the Great Crested Newt is missing and the Palmate Newt is rare. The table also shows the maximum number of captured newts for the different types of funnel traps in the surveyed pond.

Table 6: Example of data obtained in one trapping night in the surveyed pond Schwelm 2, 26.5.2012 (Mt = Minnow trap). Total number of newts caught by three funnel traps of the same type and (in brackets) maximum number of newts in one funnel trap are given.

Tab. 6: Beispiel für Daten einer Fangnacht, Gewässer Schwelm 2, 26.5.2012. Mt = Minnow trap. Angegeben sind die Gesamtsummen der Molchfänge bezogen auf jeweils drei im Gewässer ausgelegte Fallen desselben Typs und in Klammern die Maximalzahl gefangener Molche in einer Falle.

Type of funnel trap (three per type dropped out)	***Ichthyosaura alpestris***	***Lissotriton vulgaris***	***Lissotriton helveticus***	**Newts in total (for three funnel traps)**
HENF trap	26 (16)	46 (14)	4 (3)	76
Mt Gee 40opt.	33 (15)	105 (50)	3 (2)	141
Mt Plastic	14 (5)	4 (2)	0	18
Mt Gee 48	77 (31)	57 (14)	0	134
Collaps. nylon trap	1 (1)	5 (3)	0	6
Newt species in total	151	217	7	375

Table 7: Newt captures (all species pooled) in the three sections of the surveyed ponds.
Tab. 7: Molchfänge (alle Arten zusammengefasst) in den drei Sektoren der untersuchten Gewässer.

Pond	Section a	Section b	Section c	Total number of catches	Chi-square test
Hopsten HM 1	89	43	77	209	P < 0,001
Hopsten HM 2	62	35	74	171	P < 0,001
Hopsten HM 3	31	31	16	78	P > 0,05
Münster	67	63	67	197	P > 0,05
Schwelm 1	52	44	48	144	P > 0,05
Schwelm 2	114	143	118	375	P > 0,05
Total catches				1174	

Sex ratio of the total captures was equal (P>0,05, chi-square test). This could be found also for *L. helveticus* and *T. cristatus*. But in *L. vulgaris* male captures were more frequent than female ones (P<0,001), and in *I. alpestris* the opposite result was obtained (P<0,01).

On the assumption that in the three sections of the ponds newts should be caught with equal probability the number of captures are not significantly different in four of the surveyed ponds (P>0.05, chi-square test), but in two ponds (Hopsten, HM 1 and HM 2) captures are distributed unequally (P<0,001, table 7).

Discussion

The dominance of the captures of *Lissotriton vulgaris* and *Ichthyosaura alpestris* (table 5) is not surprising, because the two species are widely distributed and abundant in most parts of North Rhine-Westphalia (HACHTEL 2011, THIESMEIER et al. 2011a). In contrast *Triturus cristatus* and *Lissotriton helveticus* are missing in the nature reserve “Heiliges Meer” (KRONSHAGE et al. 2009). The latter species is also missing in the whole Münsterland region including the city of Münster (THIESMEIER et al. 2011b), but can be found mainly in the wooded region in the south of Schwelm (KRONSHAGE 1994). Thus we could catch it in the two waters in Schwelm (table 5). The rare *Triturus cristatus* is known only from four ponds in Schwelm (KRONSHAGE 1994), out of which we investigated one in our study. The finding of *Lissotriton helveticus* is new for the pond “Schwelm 2” (KRONSHAGE 1994).

As an important result of our study the efficacy of the tested trap types was very different (table 5). These differences obviously seem a consequence of their different attributes (table 1). The lowest number of captures was obtained by the collapsible nylon trap. This trap has the largest openings of all tested types, so newts seem easily to be able to get into the trap as well as out of it. The low capture numbers of the Minnow trap plastic also resulted from a too wide mesh. Therefore the small and thin specimens of *Lissotriton vulgaris* and *Lissotriton helveticus* escaped, but the bigger females of *Ichthyosaura alpestris* and both sexes of *Triturus cristatus* were not able to do so.

The best efficacy resulted from HENF trap and Minnow trap "Gee 40 opt." followed by Minnow trap "G48". If further studies should confirm this finding, these two types of trap would be most suitable for a monitoring programme, although a lot of other types are used (GLANDT 2011, 2014, SCHLÜPMANN 2009).

We tested HENF trap model I. This type has some disadvantages concerning aspects of animal welfare. For example it can be optimized (table 1) by constructing an inner wooden frame to stabilize the trap. The frame prevents the trap from collapsing. The plastic material becomes unstable after frequent use. Then it is difficult to take out tadpoles which become stuck in the trap edges. The model II (HENF-LAAR trap) is an optimized version. This model allows easier removal of newts and tadpoles from the trap by simple removing the top.

Concerning the aspects of capture success and protection of captured animals, an assessment for seven types of traps is given in colour in table 1. Five of these traps are minnow traps. Only three types of the seven are suitable for trapping amphibians (minnow trap Gee 48, HENF trap, minnow trap Gee 40 opt.), but the minnow trap Gee 40 opt. also has to be optimized furthermore (compare the colours green or green/yellow in the columns of assessment). The minnow traps have two great advantages: they are constructed of porous material and they can be taken apart into two pieces for a space-saving transport (fig. 8).

Fig. 8: Minnow traps can be taken apart into two pieces for a space-saving transport: Minnow trap type "Gee 48" taken apart into two pieces (left) and fitted into each other (right). Photo: A. Kronshage.

Abb. 8: Kleinfischreusen (Minnow traps) können einfach in zwei Hälften auseinander genommen und platzsparend transportiert werden: Kleinfischreuse Typ „Gee 48" auseinandergenommen (links) und zusammengesteckt (rechts).

Concerning the sex ratio of the specimens captured we stress that we have no knowledge about the real ratio in the surveyed populations. So we do not know whether our findings reflect the real ratio. In other studies, sex ratio of newt populations varied. For example, in *Ichthyosaura alpestris* there are populations with an equal sex ratio, but in others females dominate (THIESMEIER & SCHULTE 2010). We have to clarify if trap success is independent of the sex of the individual in our further investigations.

The equal dispersion of newt captures in the three sections of four ponds maybe a consequence of their homogeneity, whereas the unequal dispersion in the ponds Hopsten HM 1 and HM 2 may result from thermal or structural differences (submersed vegetation in HM 1) within the ponds. Another reason for the unequal dispersion maybe the different distances to woodland or open landscape to the pond shores, which cause different insolations (partly shaded shores and full sun exposed, respectively). Further investigations have to clarify this variable.

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