

# Large populations of the common toad *Bufo bufo* in Norway

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# In memory of Torstein Solhøy (TS) (1942-2013)

The common toad (*Bufo bufo* Linnaeus, 1758) is a widespread species with an extensive Euro-Asiatic distribution (note that the taxonomy of *B. bufo* has recently been revised: Recuero et al., 2012; Arntzen et al., 2013; 2014). Its northern distribution reaches 68° N in Finland (Sinsch et al., 2009) and in Norway, on the Dønna island, almost 66° 15' N (Pedersen and Dolmen, 1994). The common toad is, for the most part in and north of the Alps, an explosive breeder, i.e. the animals come together in large numbers at a breeding site for a short breeding period (Wells, 1977; Hartel et al., 2007; for exceptions see Sinsch et al., 2009). Population sizes can vary enormously both on a regional and a temporal scale, from less than 100 up to several thousands of individuals, and by a factor of up to 40 even between successive years (see Sinsch et al., 2009 for an overview).

In Scandinavia, published maximum numbers for single populations (i.e. within one breeding locality) so far are in the range of 300–500 individuals. The data are from the Trondheim area (Hemelaar, 1988) and the Bømlo area (Roth, 2011) both in Norway, and the Lund area in Sweden (Loman and Madsen, 1986). The pond in Lund is part of a complex of breeding ponds with a total maximum number of 1054 males and 614 females (Loman and Madsen, 2010). Although the

common toad is not a threatened animal in Norway (see Dolmen, 2015) and it is very common for instance on the western coastland (Salvidio et al., 1993), the species has undergone an unexplained decline regionally in south-eastern parts of the country (Semb-Johansson, 1992; Semb-Johansson et al., 2012).

In this article we present detailed information about two much larger Scandinavian toad populations, both in western Norway, with several thousand individuals. We have collected data from two localities: the lakes Nesvatnet in the county of Hordaland and Litlevatnet in the county of Møre & Romsdal.

Nesvatnet is located near Mundheim (Kvam municipality, province Hordaland; 60.1652°N/5.9375°E). The lake is eutrophic with moderate transparency, about 70000 m<sup>2</sup> in area and situated 20 m a.s.l. There exist extensive shallow water areas with dense vegetation dominated by bottle sedge *Carex rostrata*, bogbean *Menyanthes trifoliata* and water lilies *Nymphaea alba* and *Nuphar lutea*. As part of a typical Norwegian fjord landscape, the lake is located on a peninsula surrounded by suitable terrestrial toad habitats such as natural pine *Pinus sylvestris* and mixed forest, bogs, heather *Calluna vulgaris*/*Erica* spp., and, in more than half of the immediate surroundings, meadows with groups of trees (Nord et al., 2013). The catchment area of the lake is quite large, and Nesvatnet is the only suitable water body for toads in an area of about 15 km<sup>2</sup> that is bordered by the sea and by steep rocks to the north rising to 300–400 m a.s.l.

In Nesvatnet our data are based mainly on head counting by Torstein Solhøy (TS), SR and KN in 2010–2014. We usually counted once per breeding period on a relatively mild evening after sunset. The lake was covered once either by walking or by rowboat or a combination of both. Male and female toads were counted separately using hand counters. Sex determination was based on size only. In doing so, small females that were not in

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**Table 1.** Number of males and females of *Bufo bufo* at Nesvatnet (Kvam municipality, Hordaland county, Norway) 2010–2015. Numbers are based on rounded up results of head counting (see text).

Date	Males	Females	Notes
April 2010	7000-8000	700	Head counting (TS)
24.4.2011	3500-4000	500-600	Head counting (TS, SR)
20.4.2012	5000-6000	400-500	Head counting (TS, SR)
13.5.2013	4000-5000	900	Head counting (KN)
15.4.2014	2000	450	Head counting (KN, SR)
21.4.2015	3500-4500	650	Head counting (KN, SR)

copula might be counted as males, and as a result, the number of males may have been slightly overestimated and the number of females slightly underestimated. But our counting has to be considered as an underestimation of the actual number of individuals at the locality anyway, because 1) not all individuals would have been detected, 2) part of the breeding population would have already left (females after spawning) and/or 3) had not yet arrived at the lake.

The number of females was corrected by adding a very conservative estimate of females having already left, as seen from the number of egg strings. Even if the water in Nesvatnet is clear enough to see egg strings, this is a very rough approximation rather than a real count. A female lays a long, double string of small black eggs which is often twisted several times around vegetation, and egg strings from more than one female might be tangled together. If in doubt, we counted such strings as if they had been laid by one female only.

We used the exact number of our counts as the basis for a rough estimate of population size by rounding up the total number (i.e. in practice adding approximately 20% more individuals) (Table 1). We are aware that head counting is an inappropriate method to estimate an exact population size (Schmidt, 2004), but it is still considered a standard method to get an approximate population size in field herpetology (see e.g. Gent & Gibsdon, 1998; Scribner et al., 2001; Zeisset & Beebee, 2013).

We must add that the sex ratio of the common toad in breeding localities is often biased toward males (see e.g. Sinsch et al., 2009 for details), and thus, the true sex ratio of the population may deviate somewhat from our estimates.

In 2010, since the waterside of the lake was still covered with ice when the toads arrived, the toads remained on the bank, which made them easier to count even though no hand counter was used (T. Solhøy, unpublished data). So we consider this number to be a

more accurate estimation of the real population than in other years, particularly with respect to the number of males.

Litlevatnet is located near Fyrde (Volda municipality, province Møre & Romsdal; 2.0639°N/6.3384°E). It is an oligotrophic/mesotrophic lake with clear water, area about 65000 m<sup>2</sup> at an elevation of 10 m a.s.l. Litlevatnet is part of a watercourse with several lakes connected by a river. Spawning occurs first of all in the northern, shallow part of the lake, which has sparse vegetation dominated by bottle sedge, swamp horsetail *Equisetum fluviatile*, and water lobelia *Lobelia dortmanna*. The surroundings of Litlevatnet are, for the most part, rocks and scree covered with natural pine forest with bilberry *Vaccinium myrtillus* and heather. However, around the western part of the lake, and also further upstream (east) along the watercourse, there is cultivated land. From the immediate vicinity, on the northern side of the lake, the steep landscape rises to a height of 500 m or more (inclination about 1:2), while the southern side is less steep. Within a 5 km distance there are at least five more breeding localities for the common toad, four of them in the same watercourse, and the closest known is only about one km away.

Toad counting by night was carried out (by two of us: OO and GW) in Litlevatnet for most years between 1991 and 2014 (Table 2). It should be noted that the main motivation for this was not to estimate the number of toads at the breeding pond, but rather to study how the road traffic affected the migrating toads. The observations between 1991 and 2004 therefore vary with respect to number of days, weather, and duration, and they focus on different parts of the migration route: as a result, they are not directly comparable. The number of toads counted per day ranged from 197 to 1480 (Strand et al. 2009); in Table 2 only maximum numbers are given for each date.

**Table 2.** Maximum number of individuals of *Bufo bufo* for specific dates 1991–2014 at Litlevatnet (Volda municipality, Møre & Romsdal county, Norway).

Date/Year	Males + Females	Notes
1.5.1991	1223	Head counting
30.4.1992	1480	Head counting
28.4.1993	1606	Head counting
2.5.1994	1120	Head counting
19.4.2004	1208	Head counting
15.4.2009	5001	Head counting
05.4.–15.5.2010	9148 (total sum)	Fence, transport buckets
25.4.2014	3679	Head counting

With the exception of 2010, head counts were conducted. The head counting took place in the lake and along the road and included the number of road kills on several dates in the 1990s and 2000s. In 2009 a tunnel-fence system was tested for optimization of the planned rescue system; nevertheless, both head counting and collecting in buckets were conducted along different sections of the fence and in areas without fencing (Strand et al., 2009). Because of major road construction work beginning along the northern shore of the lake in 2010, a rescue project for toads was carried out. The existing fence system with 3 tunnels covered only part of the migration area and was not used by all migrating toads. Therefore, an additional makeshift drift fence of wooden planks was set up surrounding the northern part of the lake, covering the most important toad migration area. However, this 750 m long plank fence was not completely tight, and many toads managed to access the road. Hence, toads were collected in buckets (and counted) and carried over the road during periods of heavy road traffic and construction work.

Since 2011, there has been a permanent fence-tunnel system in place to ensure safe crossing of toads to their breeding site. In 2012 the amphibian rescue system was finished, although it was later improved.

In 2010 a total of 9148 migrating toads were counted between 5 April–15 May, with highest daily counts of 2447 (26 April), 1 828 (28 April) and 1835 (29 April). The highest count for one night in the 14-year long period, however, was on 15 April 2009, when 5001 individuals were counted along the shore of the lake.

With regards to 2010, it has to be kept in mind that the fence did not completely cover all migration routes, and the “rescue team” was only active during heavy road traffic (until 1–2 a.m.). Moreover, a significant proportion of the migrating toads passed unobserved

through the tunnel system towards the lake. Therefore an unknown number of toads were not recorded. A conservative estimate of the size of the migrating part of the population is approximately 12000 toads. Making a realistic assumption that we counted only about half of the total population, a population size of perhaps 18000–20000 individuals may be concluded. In one single night in 2014 (25 April), 3679 individuals were counted in the lake using the head count method from the lake shore.

Both breeding localities are situated in western Norway, with a mild, oceanic climate, and topographically located in favourable local “climate pockets” in the lowlands, with extra thermal gain from high, steep, south-facing and sun-exposed rocks. The areas are within more-or-less extensively used landscapes surrounded by natural land habitat. Both Nesvatnet and Litlevatnet are relatively small and shallow lakes and have a natural fish stock of eel *Anguilla anguilla*, trout *Salmo trutta* (in Litlevatnet also salmon *Salmo salar*) and 3-spined stickleback *Gasterosteus aculeatus* (see Nord et al., 2013). But whereas Litlevatnet is part of a system of several breeding lakes, Nesvatnet is the only suitable breeding locality within a relatively large area. Only Litlevatnet has a large breeding population of the common frog *Rana temporaria* (egg clusters from more than 500 females were counted in 2010 (Oddvar Olsen unpublished data)).

Since common toads may sometimes undertake migrations of more than 3 km (e.g. Heusser, 1969; Sinsch, 1987; Smith and Green, 2005), the area of toad habitat around a breeding locality may often be quite large. However, the toad “catchment” area around Nesvatnet, and probably also around Litlevatnet, can hardly be much more than about 3 km<sup>2</sup> (radius 1 km),

since outside these borders, the mountains become too steep and too high, or there is a (saltwater) fjord – or, at Litlevatnet, there is another lake with breeding toads, i.e. another toad population (see above). The latter assertion may of course not be valid, but in that case, the common toad population at Litlevatnet is even larger than we have stated above.

Extra-large population sizes are well known in the European common toad (see table Appendix 1). Without giving any details, Nöllert and Nöllert (1992) mention the existence of populations of 10000 individuals and possibly more. Many regional amphibian reports mention populations of several thousand individuals without giving a precise number, for example in the Czech Republic (Nečas *et al.*, 1997), in Saxony (116 populations with more than 1000 individuals listed in Zöphel and Steffens, 2002) and in the Harburg district of Germany (Westphal, 1985). Remarkably high numbers vary from 5000–15000 (e.g. Gittins *et al.*, 1980; Schiemenz and Günther, 1994; Günter and Geiger, 1996; Scribner, 2001; Ferri, 2002; Weddelling and Geiger, 2011), but the maximum estimates we are aware of are 20000 (Heusser, 1968; Schiemenz and Günther, 1994; Beinlich and Lohr, 2007), 50000 (Kuhn, 1983), and 100000 (Weddelling and Geiger, 2011; Dahlbeck, in litt.).

Our data from western Norway show the occurrence of such large populations even in the more northerly parts of the species' distribution range. This corresponds with reports of high abundance both for adults and juvenile common toads in terrestrial habitats in northern Europe (Haapanen, 1974; Sireika and Stasaitis, 1999). The description of these two lakes and surroundings are thought to be a description of a close-to-optimal toad habitat in Norway, which is also the foundation for large toad populations in this country. We are aware that head counting does not give an accurate estimate of the total toad population; only a minimum (see above). With this background, the sizes of the populations described here are even more impressive.

### Afterword

So far, amphibian rescue systems like the one at Litlevatnet, are still quite rare in Scandinavia (Fog *et al.*, 2001). The one at Litlevatnet is only the second one in Norway and has been the focus of many media reports. It was first met with a high degree of scepticism, but with time this has changed to enthusiasm. In June 2014, a toad information board was set up at Litlevatnet and at the inauguration even a gigantic sculpture of a toad

(see Reite, 2014 and a TV documentary (in Norwegian): <http://tv.nrk.no/serie/ut-i-naturen/DVNA50000912/03-03-2015>) were provided.

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**Appendix -Table 1.** Overview of extra-large populations (> 5000 adult individuals per breeding locality) of the common toad (*Bufo bufo*) in Europe. <sup>a</sup> estimated value; <sup>b</sup> value based on counting in amphibian rescue systems along roads or capture-recapture methods; <sup>c</sup> value based on a calculation of genetic diversity

Country, Region	Locality	Population size	Year	Reference
Germany, Baden-Württemberg	Alb-Donau- district, Schmiechener See	Max. 50000 <sup>a</sup>	1971–1981	Kuhn (1983)
Germany, North Rhine-Westphalia	Eifel, Urftalsperre	>100000 <sup>a</sup>	1999	Weddeling & Geiger (2011), Dalbeck in litt.
	Höxter, Grundlose-Taubenborn	17480 <sup>b</sup> ; 20000 <sup>a</sup>	2003; 2003–2007	Beinlich & Lohr (2007)
	Düren, Merkener Busch	17460 <sup>b</sup>	2007	Weddeling & Geiger (2011)
	Heiliges Meer	Ca 10000 <sup>a</sup>	1962	Feldmann (1981)
	Nordlünern	5005–6357 <sup>b</sup>	1989–1993	Loos (1992, 1994) in Günther & Geiger (1996)
	Hattingen Felderbachtal	6200 <sup>b</sup> ; >10000 <sup>a</sup>	2003	Weddeling & Geiger (2011)
	Wuppertal-Dornap	>7800 <sup>b</sup>	1999,2000	Weddeling & Geiger (2011)
	Brüggen, Voursenbeck	7511 <sup>b</sup>	Early 1990s	Weddeling & Geiger (2011)
	Rhein-Siegdistrict, Königswinter- Vinxel	6000–7000 <sup>ab</sup>	1986–1993	Oerter (1994), Günther & Geiger (1996), Weddeling & Geiger (2011)
	Wesel- district, Xanten area	6600 <sup>b</sup>	1988	Weddeling & Geiger (2011)
Germany, Thuringia	Sondershausen, Bebraer Teiche	11700 – max. 15000	2002-2005	Schlufiter in litt.
	Pößneck	10000 <sup>a</sup>	1986-1989	Schiemenz & Günther (1994)
Germany, Saxony-Anhalt	Quedlinburg	10000 <sup>a</sup>	1964	Schiemenz & Günther (1994)
Germany, Mecklenburg-Vorpommern	Sternberg	10000–20000 <sup>a</sup>	1963	Schiemenz & Günther (1994)
UK, Mid-Wales	Llandrindod Wells	7650 <sup>b</sup>	1978	Gittins et al. 1980
UK, Leicestershire	Market Bosworth	5500 <sup>c</sup>	1984?	Scribner et al. (2001)
	Springwood	12000 <sup>c</sup>	1984?	Scribner et al. (2001)
Italy, Lombardia	Lago d’Endine	5394, 10504, 12942, 18251,16245, 16500, 14687,21301 <sup>b</sup>	1993–2000	Ferri (2002)
Italy, Lombarde di Rospo municipality	Melogne, Lagod’Como	5197	2000	Ferri (2002)
Switzerland, Zürich	Thalwil (2 nearby ponds)	15000–20000 <sup>a</sup>	1962–1966	Heusser (1968)