

Recovery of *Bombina bombina* in Funen County, Denmark

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The *Bombina bombina* population has long been declining in Denmark and other parts of its range. In Denmark it was necessary to artificially raise the number of this species in five out of the remaining eight populations. The conservation work is described on four of these populations, all situated in Funen County. 69 ponds were restored or dug and the overall population grew from 82 adults in 1986–1988 to 542 in 1995–1997. The future of the populations look, in general, promising but its success will depend much on the amount of buffer zone and terrestrial habitat that it will be possible to create around the ponds in the future.

1. Introduction

The fire bellied toad (*Bombina bombina* L.) is reported to be one of the most threatened amphibians in Western Europe (Andrén et al. 1984). This species is thought to be declining and is probably one of the fastest declining amphibian species in Hungary (M. Puky pers. comm.), in the Czech Republic (J. Pialek pers. comm.) and in Poland (J. Szymura pers. comm.). The species was reported to be in decline in Denmark throughout this century (Pfaff 1943, Wederkinch 1976, Briggs et al. 1988). The situation for the species in 1988 was rather depressing and most of the management measures from 1982–1988 had failed (Briggs et al. 1988). However, valuable experience had been gained by the time it became necessary to undertake a programme of artificial rearing for five out of eight remaining Danish populations in 1987–1988. All five populations numbered under 30 adult individuals and had stopped breeding successfully in 1987. From 1989, it became possible to restore and dig new ponds on a large scale. The results and new information on the conservation of this species are presented in this paper.

This article covers four out of the five above-described populations and also nearby release sites, all situated in Funen County.

2. Methods

In total, 69 ponds were restored or dug. In the beginning of the project, existing *B. bombina* ponds were mainly dredged, and later when the frogs started migrating, many ponds were newly dug on the edge of the distribution areas. An artificial breeding programme was carried out using animals collected from three existing populations. The surviving frogs were paired as much as possible to gain a broad genetic material for the future populations. Frogs were paired in separate net cages placed in the ponds. The eggs were collected and reared in an aquarium in larger containers to the point of metamorphosis. The frogs were then released in the ponds. In some cases, frogs were kept until one year old and then released in the ponds.

All populations were monitored for calling males and breeding success every year from 1987–1997. The breeding success was estimated using a capture–recapture estimate for one-year-old individuals. In a few cases, this was also done using newly metamorphosed frogs.

A capture–recapture estimate on adults was made almost every year from 1988–1995. In some years, with the early drying up of the ponds, a capture–recapture estimate became impossible be-

cause the frogs left the ponds for the terrestrial phase. From 1996, monitoring effort was less intensive, comprising only of counts of calling males and recording of breeding success.

The juvenile (1 year old) and adult animals were individually identified using photographs of the belly pattern and the newly metamorphosed frogs by photographs of the back pattern, which in all cases are unique. All methods for estimation of the population size and yearly survival are described in Briggs (1996).

3. Results

The results of the conservation work are summarised in Table 1. The overall situation has improved from 82 adult frogs in 1988 to 542 in 1995–1997. The number of ponds with adult *B. bombina* has increased from 8 to 62 ponds and with *B. bombina* tadpoles from 1 to 18 in the period from 1986–1988 to 1995–1997. 69 ponds have been restored or dug and 3 small pieces of land bought to ensure good terrestrial habitat around the ponds.

3.1. The development in each population

3.1.1. Island 1

With only one male left in 1986, the population was extinct, and newly metamorphosed frogs artificially reared from Islands 2 and 4 were released in 1987–1988, 1990–1991 and 1993–1995. A to-

tal of 18 ponds were restored or dug. There is now a population of 90 frogs in 18 ponds. The breeding success has not been very good until 1997, which had a better breeding success that promises well for the future of the population. There is still a need for more new ponds and areas must be bought to ensure extensively grazed grasslands surrounding the ponds. The situation is still unstable.

3.1.2. Island 2

The population reached its lowest level in 1986 when it contained only 30 frogs. Artificial rearing was undertaken in 1987–1988 and a total of seven ponds were restored or dug in 1987–1990. Due to the release of metamorphosed frogs and a good breeding success after pond restoration, the population grew to 70 adults in 1991. After 1991 there was no breeding success but the population size stayed almost constant due to a high yearly survival rate (90%) of the adults until 1995 when a saltwater flood killed 80% of the population. The population will now probably become extinct. In 1978–1988 and 1990–1991 animals from Island 2 was released on Island 1. These animals on Island 1 should be found and the eggs from them reared and released on Island 2. This way it may be possible to save the genetic originality of the population on Island 2. New ponds were made in 1996 on another part of the island and dikes repaired, so that the population can thrive in future, safe from saltwater floods.

Table 1. The number of adult *Bombina bombina* in 1986–1988, 1991 and 1995–1997 and the number of occupied ponds and number of ponds with breeding success of *Bombina bombina* in 1986–1988 and 1995–1997. The locality number is the same as in Briggs et al. (1988). ex. = population extinct.

Funen County	<i>Bombina bombina</i>			Number of ponds	
	1986–1988	Adults 1991	1995–1997	Adults (tadpoles) 1986–1987	1996–1997
Island 1	1	40	90	1 (0)	18 (3)
Island 2	30	70	8	1 (0)	2 (0)
Island 4	20	75	150	2 (1)	19 (4)
Island 5	11	7	14	3 (0)	3 (1)
Locality C	20	140	170	1 (0)	8 (5)
Locality E	ex.	10	120	ex.	12 (5)
Total	82	232	542	8 (1)	62 (18)

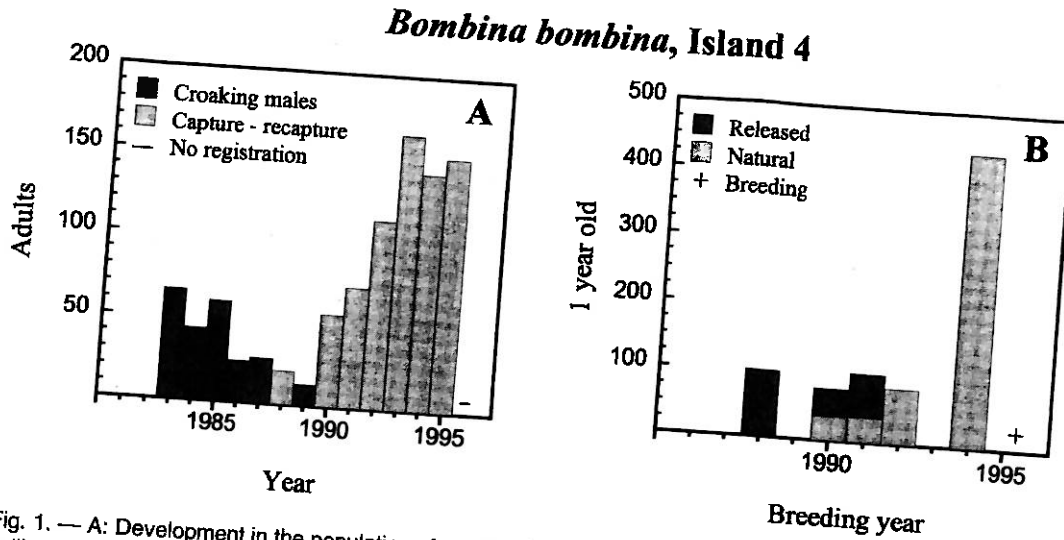


Fig. 1. — A: Development in the population of adults. Estimation can be on the basis of capture–recapture or calling males. — B: Number of 1-year-old frogs estimated from capture–recapture as a measurement of breeding success. + = No estimation done.

3.1.3. Island 4

The population low was reached in 1988 with only 20 frogs. Artificial rearing was undertaken in 1988 and 1990–1991 and a total of 26 ponds were restored or dug. The result of the last capture–recapture estimate in 1995 indicated a population of 150 adults and 450 one-year-old frogs in 19 ponds (Fig. 1). The breeding success has been very good but variable from year to year. This looks promising for the future of the population. However, all ponds are situated in intensive agricultural land and the yearly survival of the adults is low (50%). Hence, despite the good breeding success, the situation is still unstable. Buffer zones of 10 to 20 m must be made around all good ponds. The fields with the three best breeding ponds should be bought for nature conservation, so the correct watertable level can be ensured.

1.4. Island 5

The population was established in 1982 with metamorphosed frogs raised from eggs collected on and 4. The population is very small (14 in 1995) and there is only one breeding pond. This population might not survive since possibilities for the digging of new ponds are limited.

3.1.5. Locality C

The lowest number of individuals was 30 and was reached in 1988. After the artificial rearing in 1988, 1990 and 1991, the population grew to over 100 adults. Five new ponds were created between 1987 and 1990 and since 1990 there has been breeding success in one or more ponds yearly. The population has now reached 170 adults and is now stable, having reached the carrying capacity of the area. New areas must be changed from agriculture into permanent grassland and ponds made to ensure survival on a long term.

3.1.6. Locality E

The population became extinct in 1985. Newly metamorphosed frogs originating from Locality C were released in 1990–1991 and 1993–1995 and the population grew to 120 adults. Five new ponds were created or restored in 1991 and four new ponds were created in 1995–1996. There was a breeding success in 1993 and 1995–1997. The population is now growing and new areas nearby are being made suitable for *B. bombina*. It is planned to connect Localities D and C, which are situated 6 km apart, with suitable habitat.

4. Discussion

4.1. Positive and negative experiences

The last 15 years work with the conservation of *B. bombina* has brought many disappointments but also enough hope that several of the populations will survive.

4.1.1. Some positive experiences from the work

- It is now believed that loss of habitat is a more important factor of decline than the negative influence from the climatic conditions on this species' northwestern border of distribution.
- It was possible both to restore and dig ponds, which gave a good breeding success.
- *B. bombina* is very popular and landowners are willing to give space for new ponds and terrestrial habitat.
- Three to four of the populations have a good chance of survival, if sufficient money is given for habitat creation and monitoring.
- It is possible to raise enough money for creation of ponds from the Danish authorities.

4.1.2. Some negative experiences

The depressing fact is that it seems very difficult and almost impossible for the Danish authorities to raise money for buffer zones around the ponds and for buying land to ensure reserves or core areas for each population. The populations are now built up but without financial support over the next few years, for improving the terrestrial habitat around the ponds, all populations except for that in Locality E might become extinct.

4.2. Genetic variation

The populations on Islands 2 and 4 and Locality C did not become extinct and were kept genetically separate during the phase of artificial rearing. The population on Island 5 has the same ge-

netic origin as on Island 4, and Locality E the same as Locality C. Island 1 has received newly metamorphosed frogs from Islands 2 and 4.

To be sure to conserve as much genetic variation as possible, all populations should grow as fast as possible to an effective population of 500 adults. This is the number necessary to ensure that not too many alleles are lost due to genetic drift (Lehmkuhl 1984). It is not possible for all localities to reach an effective population size of 500 because of the lack of possibilities to create suitable habitats fast enough. Because of this, it is necessary to build up some new populations now, before the existing populations lose too much genetic variation.

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