Breeding by *Rana temporaria*; the importance of pond size and isolation

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Abstract: Data from 72 ponds show that the presence of breeding frogs can usually be predicted from pond size, in particular the length of shallow, unshaded shore, and isolation, i.e. the distance from a suitable summer habitats.

Introduction

In this study I present data on the occurrence of common frogs *Rana temporaria* breeding in 72 different ponds. The occurrence of breeding frogs is studied in relation to physical factors. The results are analysed in two different ways, for different purposes. First, to determine how well the use of a pond by breeding common frogs can be predicted from its size and isolation. Second, to identify physical pond characteristics that affect frog occurrence.

Method

Altogether 72 ponds (Fig. 1) were visited between 6 April and 25 April 1984. The ponds were situated in southwestern Skåne (the southernmost province of Sweden). They were distributed over an area of 40×20 km. The presence of breeding frogs or frog spawn was noted. The ponds represent a variety of types, marsh areas and old marl pits being the most common.

Five different aspects of pond size were noted: (1) area, (2) total shore line, (3) total shallow shore line, (4) total non-shaded shore line, and (5) total shallow and non-shaded shore line. Shallow refers to the slope immediately below the water line. The marl pits in particular often had very steep shores, obviously unsuitable for the breeding of the common frog. I therefore decided to treat the shallow shore line separately. Shaded shores, excluded from the last two measurements, were shores overgrown with dense bushy vegetation.

Isolation was measured as the distance from the closest suitable summer habitat. I considered ungrazed, usually moist, grassland and forests with well developed field layer suitable summer habitats. I also measured isolation as the total area of suitable summer habitat within 300 and 600 m, respectively, of the pond.

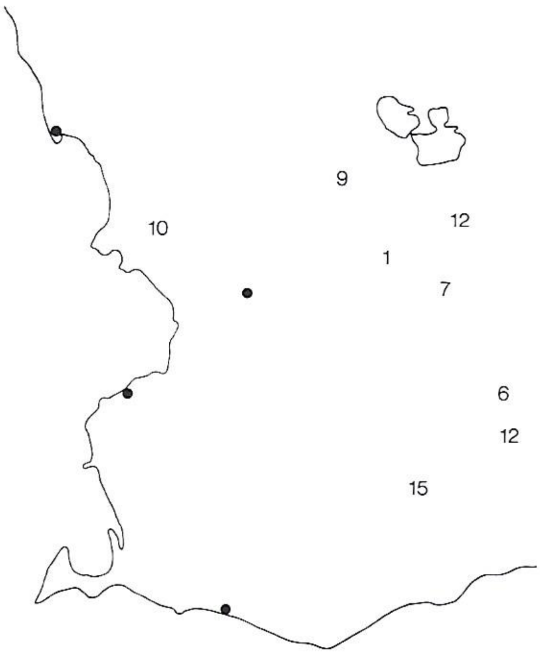

Fig. 1. The number of ponds in the different parts of the study area. Dots represent cities in southwestern Skåne.

The data were analysed by discriminant analysis. This produces a discriminant function that is based on the variables included. The discriminant function is that linear combination of variables that most efficiently separates two exclusive groups of cases. The purpose of the discriminant function is to decide to which group additional cases belong, given information of their independent variable values.

Each pond constitutes a case and belongs to one of two groups (breeding frogs present or absent). Cases with variable values that give a positive value for the discriminating function are predicted to belong to one group and those with a negative value to the other. The predictive power of the computed discriminating function is evaluated from the proportion of the original cases that are correctly assigned to either group.

Table 1. Survey of computed discriminant functions. (Area — Total pond area, Distance — Distance from potential summer habitat, Shore — Total shoreline, NSShore — Non-shaded shoreline, SlShore — Shallow shoreline, NSSlShore — Non-shaded and shallow shoreline).

Variables included		Standardized canonical discriminant function coefficients		Proportion of cases correctly grouped (%)
Size	Isolation	1st variable	2nd variable	
Area	Distance	0.71	–0.63	71
Shore	Distance	0.48	–0.79	64
NSShore	Distance	0.69	–0.59	75
SlShore	Distance	0.62	–0.65	72
NSSlShore	Distance	0.77	–0.49	81

In the present study, discriminating functions were computed from all combinations of one pond size variable and one isolation variable. The power of each function was evaluated from the proportion of the 72 ponds that it correctly assigned to either of the two groups; breeding frogs present or absent.

For the second analysis I directly compared size and isolation of ponds with and without breeding ponds. A statistically significant difference indicates the importance of the factor.

Table 2. Actual group and group predicted by discriminant function based on length of non-shaded, shallow shore line and distance from closest potential summer habitat for the 72 studied ponds.

Actual group	No of cases	Predicted group No breeding	Predicted group Breeding
No breeding	50	44	6
Breeding	22	8	14

Results

The discriminating function that correctly assigned most of the 72 study ponds to the groups breeding and non breeding respectively was based on the distance of the pond from the closest potential summer habitat and the total length of the shallow, non-shaded shore line (Table 1). It assigned 81% of the ponds to the correct group (Table 2).

There were significant differences between ponds with and without breeding frogs in the length of shallow shore, length of shallow and non-shaded shore and in distance from the closest summer habitat (Table 3). The difference in the length of shallow shore was also significant when only ponds with at least some shallow shore were considered ($t=1.98$, d.f.$=58$, $P<0.05$).

Table 3. Characteristics of ponds with and without breeding frogs.

	Ponds with breeding frogs (N=22)		Ponds without breeding frogs (N=50)		t	P
	Mean	SD	Mean	SD		
Area (ha)	0.26	0.43	0.08	0.16	1.88	>0.05
Shoreline (m)	192	177	118	156	1.47	>0.10
Non-shaded s.	180	211	84	104	1.98	>0.05
Shallow s.	168	187	64	162	2.00	<0.05
Non-shaded and shallow shore	162	222	45	103	2.36	<0.05
Distance from summer habitat (m)	118	117	282	321	3.16	<0.01
Total summer hab. within 300 m (ha)	6.63	7.30	5.60	7.21	0.54	>0.10
D:o within 600 m	23.6	16.7	19.7	20.9	0.84	>0.10

Discussion

The results indicate that the use of a pond as a breeding site by the common frog depends on its size and position in the landscape. The most important aspect of size seems to be the amount of shoreline that is shallow and not strongly shaded. The importance of the location of breeding ponds has also been pointed out by Wederkinch (1989) in a study of *Rana dalmatina*.

The mechanism by which these factors affect frog utilization of ponds cannot be determined from a descriptive study. However, I'd like to suggest some hypotheses. It is likely that migration between the summer habitat and breeding pond is associated with some predation mortality. A landscape with ponds close to the summer habitat is thus likely to support more frogs than one where these lie further away. Furthermore, if ponds that are similar in other respects lie at different distances from a summer habitat, one would expect some mechanism to operate that makes the frogs prefer those ponds that are close to the summer habitat.

If there is competition between frog larvae one would expect the occurrence of mechanisms that make frogs avoid overcrowded breeding sites. Common frogs always breed in the shallow part of a pond (pers. obs.) and the importance of this for the temperature climate of the eggs is easy to understand. If the carrying capacity is also somehow related to the amount of shallow and non-shaded shore this could produce the pattern suggested by this study.

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References

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