Turk J Zool
31 (2007) 255-260

Population Size of the Marsh Frog (*Rana ridibunda* Pallas, 1771) in Lake Yayla (Denizli, Turkey)

Dinçer AYAZ[1,*], Cemal Varol TOK[2], Ahmet MERMER[1], Murat TOSUNOĞLU[2], Murat AFSAR[3], Kerim ÇİÇEK[1]

[1]Ege University, Faculty of Science, Biology Department, 35100, Bornova, İzmir - TURKEY

[2]Çanakkale Onsekiz Mart University, Faculty of Science and Literature, Department of Biology, 17020, Çanakkale - TURKEY

[3]Celal Bayar University, Faculty of Science and Literature, Department of Biology, 45030, Manisa - TURKEY

Received: 13.03.2006

Abstract: The population size of marsh frogs (*Rana ridibunda*) was estimated using the mark-recapture method in Lake Yayla (Buldan, Denizli, Turkey). According to the results, the mean estimated population was 14,733 and the sex ratio was female biased (male: female, 0.56). The main limiting factors of the marsh frog population are also outlined.

Key Words: Marsh frog, *Rana ridibunda*, Lake Yayla, population size, sex ratio

Yayla Gölü (Denizli, Türkiye) Bataklık Kurbağası (*Rana ridibunda* Pallas, 1771) Populasyonunun Büyüklüğü

Özet: Bu çalışmada, Yayla Gölü (Buldan, Denizli)'ndeki bataklık kurbağalarının populasyon büyüklüğü markalama-tekrar yakalama metodu kullanılarak hesaplanmıştır. Araştırma sonuçlarına göre, türün buradaki ortalama populasyon büyüklüğü, 14.733 ve eşey oranı, dişi eğilimlidir (erkek: dişi, 0,56). Bataklık kurbağası populasyonunu sınırlayıcı faktörlere de dikkat çekilmiştir.

Anahtar Sözcükler: Bataklık kurbağası, *Rana ridibunda*, Yayla Gölü, populasyon büyüklüğü, cinsiyet oranı

Introduction

The global decline of amphibians (Blaustein and Wake, 1990; Alfold and Richards, 1999; Houlahan et al., 2000) urgently calls for a better understanding of the dynamics of amphibian populations (Meyer et al., 1998; Wake, 1998). Numerous studies of population size, structure, and dynamics of amphibians have been conducted since the 1950s (e.g., Turner, 1960; Pope and Matthews, 2001; Richter and Seigel, 2002; Watson et al., 2003).

The marsh frog, *Rana ridibunda,* is highly riparian, being restricted to aquatic margins, and rarely moves far from water bodies. Several studies of the marsh frog have been conducted on various aspects of its natural history and ecology, including feeding (e.g., Cogălniceanu et al., 2000), breeding (e.g., Pagano et al., 2001; Holenweg Peter et al., 2002), habitat use (e.g., Holenweg Peter et al., 2001), and population fluctuations (e.g., Gokhelashvili, 1998; Plenet et al., 2000; Peter, 2001). The natural history and ecology of the Caucasian population of the species have also been summarized by Tarkhnishvili and Gokhelashvili (1999). Studies of the population status of *R. ridibunda* in Turkey have been limited to those conducted by Baran et al. (1992) and Kaya and Erişmiş (2001), and our knowledge of many of Turkey's *R. ridibunda* populations is inadequate.

Compared to other Aegean populations, the Lake Yayla population inhabits considerably high altitudes where climatic conditions are very harsh in winter. The objective of this study was to establish the population size and sex ratio of a population and to contribute to the

*E-mail: dincer.ayaz@ege.edu.tr

rather limited knowledge of the ecology of the species, which is widespread in Turkey.

Materials and Methods

Study Site

The study site was Lake Yayla (lat 38º03´N, long 28º46´E), located on the Süleymanlı Plateau on the southern slopes of Mount Sazak, 8 km west of Buldan township of Denizli, Turkey (Figure 1). It is 1150 m above sea level and covers an area of 50 ha. Small creeks around Lake Yayla are fed by snow and rain water.

A decline in the amount of water carried by sources feeding the lake and a decrease in the rate of annual rainfall both cause the water level to drop considerably, especially in the summer months. The maximum depth of the lake is 110 cm and surface temperatures range between 9.0 and 22.7 ºC throughout the year (Ustaoğlu et al., 2003). Dominant plants in the lake vegetation include Common Spike Rush (*Eleocharis palustris*), Tufted Sedge (*Carex elata*), Pondweed (*Potamogeton* spp.), and Tropical Hornwort (*Ceratophyllum submersum*). The fauna of the lake is comprised of the following: 1) Fish: Nose (*Chondrostoma nasus*) and Silver Crucian Carp (*Carassius gibelio*); 2) Amphibians: Southern Crested Newt (*Triturus karelinii*), Marsh Frog (*Rana ridibunda*), Common Tree Frog (*Hyla arborea*), and Green Toad (*Bufo viridis*); 3) Reptiles: European Pond Turtle (*Emys orbicularis*), Grass Snake (*Natrix natrix*), and Dice Snake (*Natrix tessellata*); 4) Nesting birds: Avocet (*Recurvirostra avosetta*), Little Bittern (*Ixobrychus minutus*), White Stork (*Ciconia ciconia*), Ruddy Shelduck (*Tadorna ferruginea*), Greylang Goose (*Anser anser*), Gadwall (*Anas strepera*), and Mallard (*Anas platyrhynchos*).

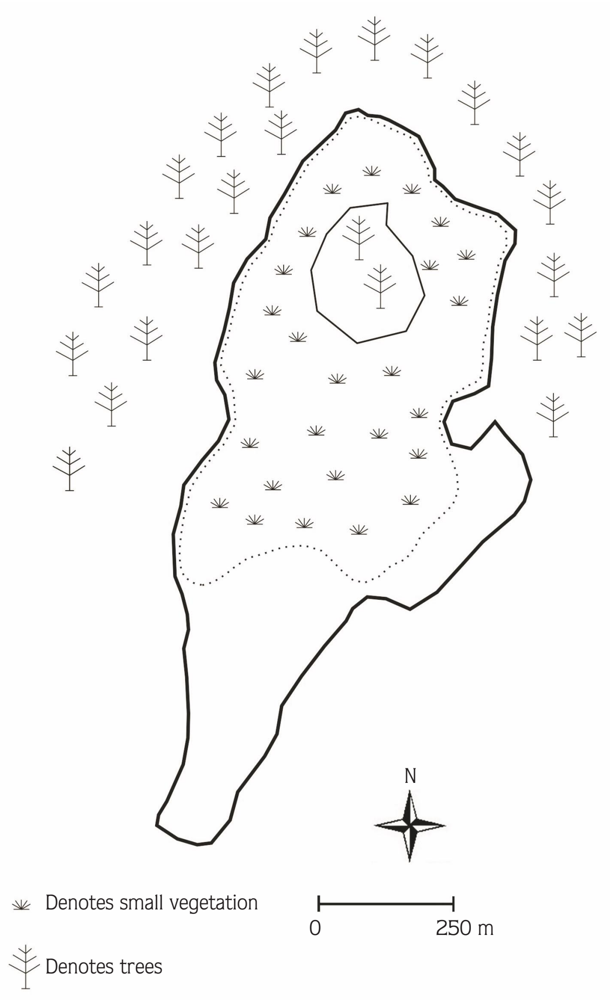

Figure 1. Lake Yayla (modified from Ustaoğlu et al., 2003).

Field Work

Frogs were captured between 2200 and 0300 on June 19 (Day 1), 21 (Day 2), and 24 (Day 3) 2005, they were marked by clipping their toes according to the Donnelly system (Donnelly et al., 1994), and their snout-vent lengths (SVL) and sexes were recorded. On each day of the study, 4 observers conducted surveys by randomly walking around the lake. Frogs were captured from all parts of the lake in an effort to represent the population of the entire lake. As we were not able to determine the secondary sex characteristics of all the specimens, individuals measuring < 41.36 mm were considered juveniles, as recommended by Tarkhnishvili and Gokhelashvili (1999). Sterile surgical scissors were used for clipping their toes and an iodine-based antiseptic solution (Isosol) was applied to prevent any contamination of the parts that were cut. Subsequently, it was observed that there were no signs of contamination in the marked specimens that were recaptured and that the cuts had began to heal. Air and water temperature were measured and recorded separately for each day on which the study was carried out. During the study, the water temperature was 21.5, 22.5, and 22.6 °C, and the air temperature was 20, 19.4, and 19.5 °C, respectively.

Data Analysis

We assumed that the population was closed (no births, deaths, or migration) in consideration of the brief study period. Population size was estimated using the triple catch method (Begon, 1979). Significance of difference in SVL values between the sexes was tested using the chi-squared test (Sokal and Rolf, 1995).

Results

Population Size

In all, 1623 specimens (322 males, 573 females, and 728 juveniles) were marked in the course of the study. On day 1, 522 individuals (106 males, 134 females, and 282 juveniles) were captured, marked, and released. On day 2, 103 males, 279 females, and 250 juveniles were caught. In this sampling process, 2 males, 4 females, and 2 juveniles, marked on day 1, were recaptured. In the sampling made on day 3, 493 individuals (120 males, 171 females, and 202 juveniles) were captured. Of these, 2 males, 2 females, and 1 juvenile were recaptures from day 1; and 3 males, 5 females, and 3 juveniles were recaptures from Day 2. According to the data, the population size was 19,113 and the survival rate was 0.52, with a gain of 0.04 on day 2. We assumed that survival and gain rates were constant and the interval between the samples was the same (Begon, 1979). The population size was 10,353 on day 3 and the mean population size was 14,733, according to the triple catch.

Body Size and Sex Ratio

SVL was 71.84 mm ± 1.07 (mean ± CI) (range: 49.56-110.80 mm) in males, 80.10 mm ± 0.88 (range: 51.05-104.78 mm) in females, and 35.01 mm ± 0.23 (range: 27.90-41.36 mm) in juveniles (Figure 2). Females had significantly longer SVLs than males (chi-squared test: 0.941; P = 0.001). The male to female ratio of the Lake Yayla population was 0.79:1 on day 1; 0.37:1 on day 2; and 0.70:1 on day 3 (mean: 0.56:1). Juveniles constituted a considerable portion of the population. Specimens with newly developed tails, as well as those whose tails had already dropped off, were among the juveniles that were investigated.

Predation

Potential predators in this site included aquatic birds, such as *Anser anser* and *Ixobrychus minutus*, and reptile species, such as *Emys orbicularis*, *Natrix natrix*, and *Natrix tessellata*. *N. natrix*, *N. tessellata*, and *E. orbicularis*, which are numerous in the lake, pose a serious threat to adult individuals, whereas aquatic insect fauna, aquatic birds, and large fish populations (there is no fishing activity in the lake) pose the greatest threat to eggs, larvae, and juveniles. Large flocks of birds prey on vulnerable individuals in shallow parts of the lake, especially between 1000 and 1200, and between 1300 and 1500.

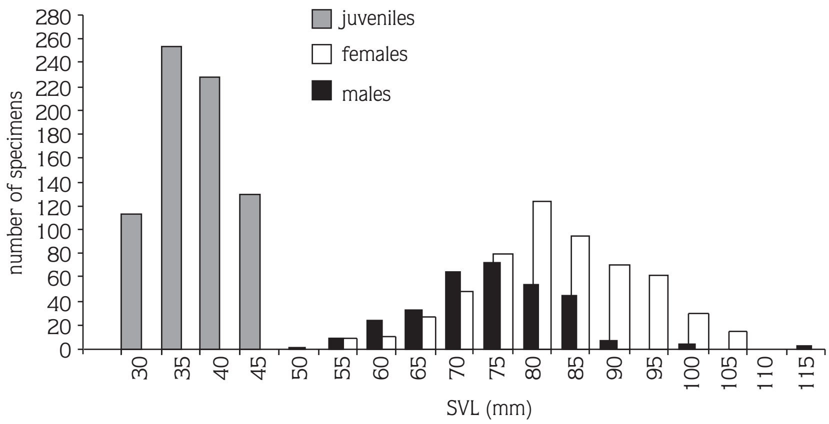

Figure 2. SVL size distribution of 1623 *Rana ridibunda* specimens captured in June 2005.

Discussion

Lake Yayla has dense vegetation allowing the breeding of frogs. In addition, it has dense coleopteran and dipteran populations due to manure from sheep and cattle grazing, forest vegetation, and large amounts of aquatic insects and other insect groups, which are also conditions suitable for feeding of frogs. Individuals can breed easily under these favorable conditions; thus, the size of the population is higher in direct proportion to the fertility of the biotope.

While the population size of Lake Akören (Afyonkarahisar) was reported as 3274 (Kaya and Erişmiş, 2001), that of Lake Çivril (Denizli), which is very close to Lake Yayla, was 7222 ind. km^{-2} (Baran et al., 1992). Considering the fact that population size largely depends on environmental factors, the Lake Çivril population is expected to be larger as it covers a larger area (4000 ha) and, consequently, houses larger communities. In a stock determination study that was conducted for all regions of Turkey, Baran et al. (1992) established that the Lake Poyrazlar (1200 ha) population was denser as compared to other lakes that were investigated. According to the data we obtained in the present study, it can be stated that the Lake Yayla population (14,733 ind. 0.5 km^{-2}) is closer to that of Lake Poyrazlar (41,667 ind. km^{-2}) when compared with respect to population sizes and the areas they inhabit.

There are certain differences between female and male individuals, as far as SVL is concerned. Sexual size dimorphism, with larger females than males, is generally seen in anurans (Shine, 1979). Furthermore, female-biased sex ratios (male to female < 1:1) were observed in our study. Studies carried out on different anuran species have also revealed that males either outnumber females (Vences et al., 1999) during the breeding season or exist in equal numbers (Combes, 1967). However, females outnumbering males is a predictable result under normal conditions (e.g., Sperling et al., 1996; Ryser, 1996; Knietz, 1998; Kaya and Erişmiş, 2001; Richter and Seigel, 2002). The female-biased sex ratio we observed represents the entire population. The observed sex ratio was simply due to younger aged adult males than that of adult females, which was supported by the size differences. If males maturate earlier than females, the younger generation has more males and the older generation has less males. Juveniles constituted 44.8% of the marked specimens. Of course, every younger generation should usually have more individuals than an older one (e.g., Vences et al., 1999).

In coastal areas of the Aegean Region, the breeding season of the species starts in early March and continues until the end of April (Çaydam, 1973). In colder climates, however, the breeding season can last through the end of June (Tarkhnishvili and Gokhelashvili, 1999). In view of the fact that Lake Yayla is in a mountain forest zone, far lower than subalpine and alpine, air and water temperatures can display considerable variation. Breeding continues until the end of May due to cold weather conditions, which most probably stems from delays in the completion of the post-metamorphic development of the individuals and their search for shallow waters to more easily find food. However, this largely increases the possibility of their falling prey to predators or being captured. In a series of interviews with local people, it was learned that a large number of individuals from the population in question were collected to be exported in 2003. This might explain the observation that the majority of the individuals in the population were juveniles.

Possible predators of the species inhabiting the area we have investigated largely destroy the juveniles trapped in the shallow parts of the lake. Flocks of birds gathering over the lake prey on vulnerable individuals in shallow waters between 1000 and 1200, and 1300 and 1500. Furthermore, *Emys orbicularis,* a species densely inhabiting the lake, is another factor contributing to the destruction of the population. Predators also posing a serious threat to the Caucasian populations of the species include *Natrix natrix*, *Natrix tessellata*, and various aquatic birds (Bannikov et al., 1977).

Although *Rana ridibunda* is not considered an endangered species, it is forced to adapt to different biotopes, such as forests and grasslands, as their habitats are being destroyed as an inevitable outcome of urbanization. Consequently, the species has started to occupy the habitats of other species, such as *Rana macrocnemis* (Tarkhnishvili, 1997), and will most probably cause a substantial decrease in the size of some amphibian populations. So as to protect other endangered species, detailed and lengthy investigations should be conducted on *R. ridibunda* populations, and certain restrictions should be imposed on these populations if need be. On the other hand, many marsh frog populations in Turkey suffer serious losses because they are ignorantly collected for export purposes (Baran et al., 1992). For this reason, it is extremely important that studies be conducted on the present condition and sustainability of the populations, especially in regions where there are extensive export activities (e.g., Thrace and Lake District).

Acknowledgements

We thank Dr. David N. Tarkhnishvili for his invaluable comments on the earlier version of the manuscript. This study constitutes part of a project [Project No: TBAG-2402 (103T189)] supported by TÜBİTAK (The Scientific and Technological Research Council of Turkey). We are indebted to TÜBİTAK for the financial support it has provided.

References

Alford, R.A. and Richards, S.J. 1999. Global Amphibian Declines: a problem in applied ecology. Annu. Rev. Ecol. Syst. 30: 133-165.

Bannikov, G.A., Darevsky, I.S., Ishchenko, V.G., Rustamov, A.K. and Szczebak, N.N. 1977. Guide to Amphibians and Reptiles of the USSR Fauna, Prosveshchenie Publ., Moscow.

Baran, İ., Yılmaz, İ., Kumlutaş Y. and Kete, R. 1992. Türkiye Ova Kurbağasının (*Rana ridibunda*) Stok Tesbiti (Anura, Ranidae). Turk. J. Zool. 16: 289-299.

Begon, M. 1979. Investigating animal abundance: capture-recapture for biologists, University Park Press, Baltimore.

Blaustein, A.R. and Wake, D.B. 1990. Declining amphibians: a global phenomenon? Trends in Ecology and Evolution 5: 203-204.

Cogãlniceanu, D., Palmer, M.W. and Ciubuc, C. 2000. Feeding in Anuran Communities on Islands in the Danube floodplain. Amphibia-Reptilia 22: 1–19.

Combes, C. 1967. Biologie, écologie des cycles et biogéographie de Digènes et Monogènes d'Amphibiens dans l'Est des Pyrénées, Unpublished thesis, Faculté des Sciences de Montpellier, Paris, 196 pp.

Çaydam, Ö. 1973. İzmir'de bulunan Anura türlerinden *Bufo bufo*, *Bufo viridis* (Bufonidae), *Rana ridibunda* (Ranidae), *Pelobates syriacus* (Pelobatidae) ve *Hyla arborea* (Hylidae)'nın üreme biyolojisi üzerine araştırmalar. E.Ü. Fen Fak. İlmi Raporlar Serisi No. 198: 1-22.

Donnelly, M.A., Guyer, C., Juterbock, J.E. and Alford, R. 1994. Techniques for marking amphibians. In: Measuring and monitoring biological diversity, standard methods for amphibians (eds. W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, M.S. Foster), Smithsonian Institution Press, Washington, DC, pp. 277–284.

Gokhelashvili, R.K. 1998. Age structure and its dynamics in populations of amphibians from Georgia. PhD Thesis, Tbilisi State Univ., Tbilisi, 118pp.

Holenweg Peter, A.K., Reyer, H.U. and Abt Tietje, G. 2001. Homing behavior of *Rana lessonae*, *R. ridibunda* and their hybridogenetic associate *R. esculenta* after experimental displacement. Amphibia-Reptilia 22: 475-480.

Holenweg Peter, A.K., Reyer, H.U. and Abt Tietje, G. 2002. Species and sex ratio differences in mixed populations of hybridogenetic water frogs: The influence of pond features. Ecoscience 9: 1-11.

Houlahan, J.E., Findlay, C.S., Schmidt, B.R., Meyer, A.H. and Kuzmin, S.L. 2000. Quantitative evidence for global amphibian population declines. Nature 404: 752-755.

Kaya, U. and Erişmiş, U.C. 2001. Marsh Frogs, *Rana ridibunda* in Lake Akoren - 26 August National Park (Afyon): A preliminary study of population size and a taxonomical evaluation. Turk. J. Zool. 25: 31-34.

Kneitz, S. 1998. Untersuchungen zur Populationsdynamik und zum Ausbreitungsverhalten von Amphibien in der Agrarlandschaft, Laurenti Verlag, Bochum.

Meyer, A.H., Clobert, J. and Grossenbacher, K. 1998. Analysis of three amphibian populations with quarter-century long time-series. Proc. Roy. Soc. London, B 265: 523-526.

Pagano, A., Joly, P., Plenet, S., Lehman, A. and Grolet O. 2001. Breeding habitat partitioning in the *Rana esculenta* complex: the intermediate niche hypothesis supported. Ecoscience 8: 294-300.

Peter, A.K.H. 2001. Survival in adults of the water frog *Rana lessonae* and its hybridogenetic associate *Rana esculenta*. Canadian Journal of Zoology 79: 652-661.

Plenet, S., Hervant, F. and Joly, P. 2000. Ecology of the hybridogenetic *Rana esculenta* complex: differential oxygen requirements of tadpoles. Evolutionary Ecology 14: 13-23.

Pope, K.L. and Matthews, K.R. 2001. Movement ecology and seasonal distribution of mountain yellow-legged frogs, *Rana muscosa*, in a high-elevation Sierra Nevada basin. Copeia 787-793.

Richter, S.C. and Seigel, R.A. 2002. Annual variation in the population ecology of the endangered gopher frog, *Rana sevosa* Goin and Netting. Copeia 962-972.

Ryser, J. 1996. Comparative life histories of a low- and a high-elevation population of the common frog *Rana temporaria.* Amphibia-Reptilia 17: 183-195.

Shine, R. 1979. Sexual selection and sexual dimorphism in the Amphibia. Copeia 297-306.

Sokal, R.R. and Rohlf, F.J. 1995. Biometry, 3rd ed. Freeman, New York.

Sperling, P., Vences, M. and Böhme, W. 1996. Vorläufige Bemerkungen zum taxonomischen Status von *Rana temporaria honnorati* Héron-Royer, 1881. Salamandra 32: 99-112.

Tarkhnishvili, D.N. 1997. The Status of Amphibian Species in Georgia (C.I.S). DAPTF Reports series, 79. J.W. Wilkinson (ed.), The Open University, Milton Keynes (UK): 1-17.

Tarkhnishvili, D.N. and Gokhelashvili, R.K. 1999. The Amphibians of the Caucasus, Pensoft Publications, Sofia.

Turner, F.B. 1960. Population structure and dynamics of the western spotted frog, *Rana p. pretiosa* Baird & Girard, in Yellowstone National Park, Wyoming. Ecological Monographs 30: 251–278.

Ustaoğlu, R, Balık, S., Aysel, V., Sarı, H.M., Özdemir, D., Aygen, C., Özbek, M., Taşdemir, A., Yıldız, S., İlhan, A. and Topkara, E.T. 2003. Yayla Gölünün (Buldan-Denizli) Limnolojik Yönden Araştırılması. E.Ü. Araştırma Fonu 2000/SÜF/008 nolu proje, 39s.

Vences, M., Piqué, N., Lopez, A., Puente, M., Miramontes, C. and Vieites, D.R. 1999. Summer habitat population estimate and body size variation in a high altitude population of *Rana temporaria*. Amphibia-Reptilia 20: 431-435.

Wake, D.B. 1998. Action on amphibians. Trends Ecol. Evol. 13: 379-380.

Watson, J.W., McAllister, K.R. and Pierce, D.J. 2003. Home ranges, movements, and habitat selection of Oregon Spotted Frogs (*Rana pretiosa*). Journal of Herpetology 37: 64-74.