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Usefulness of volunteer data to measure the large scale decline of "common" toad populations

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ABSTRACT

Measuring a species decline is pivotal to evaluate their conservation status, but an accurate assessment of demographic trends requires observations collected across broad spatial and temporal scales. Volunteers can help to collect information over large scales, but their data may be affected by heterogeneity for sampling efforts and protocols, which may influence detection probability. Ignoring this issue may conduct to misleading conclusions. Here we show that data collected by different volunteer groups can be integrated with measures of sampling efforts, to obtain information on large scale demographic trends. We collected data on 33 common toad (*Bufo bufo*) populations across Italy for the period 1993–2010. We used two approaches (meta-analysis; analysis of average change in population size) to evaluate the overall demographic trend. We incorporated measures of volunteer sampling efforts into analyses, to take into account changes in detection probability. Toad abundance significantly declined in the last decade. From 2000 to 2010, 70% of populations showed a strong decline, and only 10% increased. Trends were heterogeneous among populations, but taking into account sampling effort reduced heterogeneity by 40%. We detected a 76% cumulative average decline of toad populations, despite an increasing mean sampling effort. The widespread toad decline rises concern for its future, also because the causes remain unclear. Volunteer data can be extremely useful to identify large scale population trends, if information on sampling effort are recorded and used to adjust counts.

1. Introduction

In the last two decades, a growing body of evidence has shown that amphibians are declining at the global scale (e.g., Houlahan et al., 2000): many populations and species have shrunk or even disappeared at the local or regional scale (Meyer et al., 1998; Lips et al., 2004; Griffiths et al., 2010). Knowledge of the amount and rate of species decline, and in which populations it occurs, is paramount to evaluate their conservation status. For instance, observing a reduction in population size, or strong demographic oscillations associated with small population size, are key criteria used by the IUCN to assess whether species are threatened by extinction (IUCN, 2001). However, documenting a decline can be challenging. First, populations may undergo natural demographic fluctuations. For instance, many amphibian populations are known to exhibit natural demographic cycles, with strong year-to-year variation even in absence of a true decline (Pechmann and Wilbur, 1994; Meyer et al., 1998; Green, 2003). Only observations collected across a long time span may allow an accurate assessment of demographic trends (Schmidt et al., 2005; Salvidio, 2009). Moreover, observations covering multiple populations across broad spatial scales are needed for an exhaustive assessment of species status (Storfer, 2003). Unfortunately, the collection of data over large spatial and temporal scales is complex and requires time, money, personnel, and the resources for their training (e.g., Reading et al., 2010; Selonen et al., 2010; Cameron et al., 2011).

The use of volunteers can help to overcome the difficulties of broad scale monitoring. Volunteers can be extremely useful to conduct biodiversity monitoring, as well as increasing public percep-

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tion and involvement toward conservation issues (Carrier and Beebee, 2003; Bell et al., 2008; Schmeller et al., 2009; Sewell et al., 2010). For instance, in Europe, at least 40,000 volunteers participated to nearly 400 independent schemes of biodiversity monitoring from 2005 to 2007, 15% of which focused on the herpetofauna (Schmeller et al., 2009). The availability of so many volunteers allowed the collection of a large amount of data that could not be obtained with the use of professionals only (Schmeller et al., 2009). Nevertheless, some concern exists about the actual usefulness of volunteer data (e.g., Genet and Sargent, 2003; Brashares and Sam, 2005). If volunteer groups follow different monitoring protocols, their data may be extremely heterogeneous. When indexes of population abundance are collected, special care is needed to identify and control the factors influencing species detectability (e.g., Williams et al., 2002). Detectability can be variable across time and space because of multiple factors, including environmental conditions, monitoring protocols, and even because observers with different expertise record data on different populations or during different years (Link and Sauer, 2002; Sauer et al., 2010). It might therefore be difficult integrating such volunteer counts to obtain reliable information for the analyses of population trends (Link and Sauer, 1998).

The common toad (*Bufo bufo*) is a widespread species, inhabiting large areas of Europe and Western Asia. Although classified as 'least concern' by the IUCN (Agasyan et al., 2008), analyses suggested that the common toad may be declining in some European countries (Carrier and Beebee, 2003; Schmidt and Zumbach, 2005). Vehicular traffic causes high mortality to toads crossing roads during breeding migrations. For this reason, in several European countries mitigation measures are established, frequently managed by groups of volunteers (Langton, 1989; Schmidt and Zumbach, 2008). Volunteer groups sometimes rescue toads over many years, with important consequences on mortality, and can also collect a large amount of data on the crossing individuals. Obtaining quantitative estimates of toad decline is difficult (Schmidt and Zumbach, 2005), but the availability of a large amount of data collected by volunteers may help to achieve this task.

The aim of this study was obtaining quantitative measures of population changes of the common toad over broad temporal and spatial scales, through the use of volunteer data. We integrated yearly abundance data, collected by different groups of volunteers, on 33 Italian toad populations. For these populations, in night-time during the migration period, volunteers walk along the stretch of roads where the migration occurs, gathering the toads to transfer them to the other side, and recording the number of toads crossing the road toward the breeding site as a measure of toad abundance. A single time series may have bias or may only represent a local situation. However, observing a coherent trend among multiple series collected over the same period, and representing populations spread through a wide region, may provide useful information on the overall trend of a species (Houlahan et al., 2000). Variation in monitoring effort across years may affect detection probability, therefore we integrated measures of volunteers sampling efforts in our analyses (Schmidt, 2004). We used the meta-analysis approach to combine results from multiple, heterogeneous sources and obtain a reliable measure of the overall strength of the demographic trend (Arnqvist and Wooster, 1995). Furthermore, we combined data from multiple populations to obtain quantitative estimates of the overall population changes in time using the ΔN method, an approach allowing the analysis of average changes in population size (Houlahan et al., 2000). We also show that adjusting counts with the measures of the sampling efforts can greatly reduce data heterogeneity and improve the robustness of conclusions.

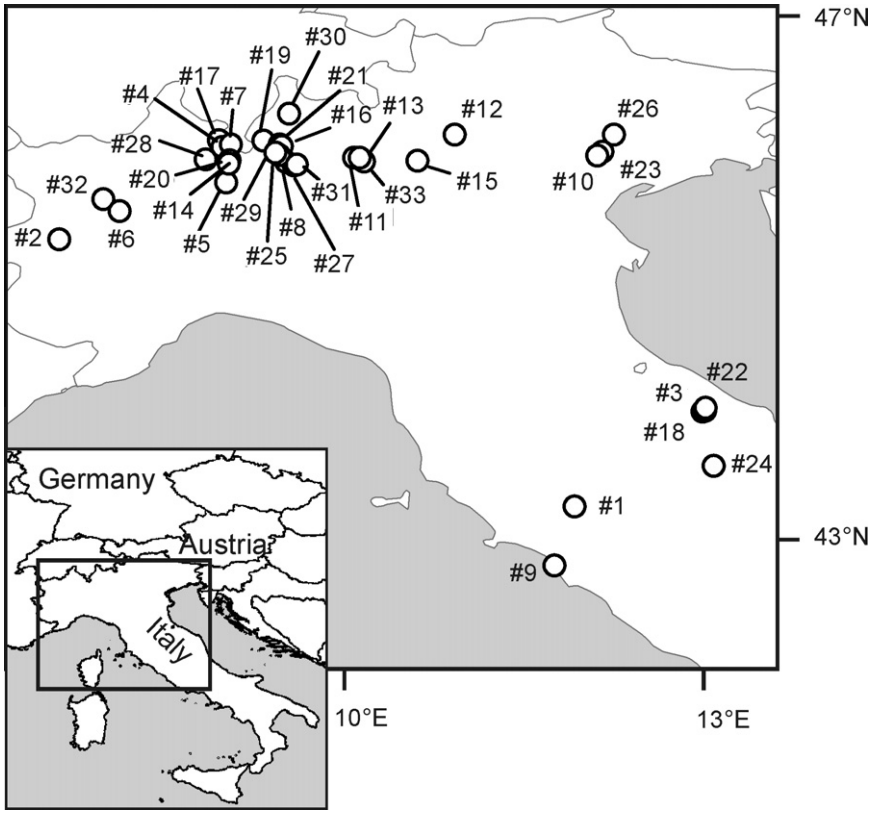

Fig. 1. Distribution of the 33 toad populations in Italy. See Table A1 in Supplementary material for further details on populations.