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Amphibian and reptile communities in eleven Sites of Community Importance (SCI): relations between SCI area, heterogeneity and richness

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Abstract. Seven species of amphibians and reptiles were observed in eleven Sites of Community Importance (SCI) of the Lodi Province (NW Italy). Distribution and relative abundance of amphibians appeared more variable than reptiles. Some species of conservation concern as *R. latastei* were influenced by habitat physiognomy, i.e. the surface of wooded areas are important in predict presence and relative abundance of this species. SCI with wider surfaces and higher habitat heterogeneity included higher number of species. Species richness, here considered as a raw index of biodiversity value and community quality, was significantly related to SCI area and habitat heterogeneity; since this significant positive relation is confirmed both for amphibians and reptiles we suggest that, in planning of natural areas, priority must be retained for biotopes able to host the higher number of species.

Keywords. Amphibians, reptiles, SCI, richness, habitat heterogeneity, Italy.

INTRODUCTION

Animal communities are the results of two main differing forces; the ecological forces determine the stability of an assemblage, while the evolutive forces determine the pattern of coexistence between different populations (Stenseth, 1989). Communities parameters such as richness and species diversity are moreover influenced by several factors such as habitat surface and heterogeneity, and by a number of limiting factors, as management at ecosystem level, or vulnerability to allogenic invasions (Krebs, 2001). The indipendent analysis of these factors is often very difficult as well as their influence on animal community; scaling problem, for example, is one of the most difficult to resolve in several vertebrate community (Webb, 1989). Amphibian and, to a lesser extent, reptile communities are known to be vulnerable to several external enviromental factors such as managed alteration of primaeval habitats (Ryan et al., 2002; Ernst et al., 2006), fragmentation (Russell et al., 2002), pollution (Lebboroni et al., 2006), infections (Bosch and Martinez-Solano, 2006; Rachowicz et al., 2006), and to wide-scale global change (Pounds et al., 2006). Due to this vulnerability, amphibians are considered as a good primer in evaluating habitat quality (Rondinini and Boitani, 2006).

All these factors should be taken into account when amphibian/reptilian community parameters are investigated in protected areas, and when a correct planning should include patches size and habitat heterogeneity, aimed at improving conservation effort and its output (Freemark et al., 2006; Garcia, 2006).

The aim of this study is to: (1) check for presence and abundance of amphibian and reptilian communities in the eleven Sites of Community Importance of the Lodi Province, (2) describe relationships between community richness, patches size and habitat heterogeneity, and (3) check the suitability of the current asset of SCI of the Lodi Province for amphibian and reptilian conservation.

MATERIALS AND METHODS

The study was carried out from April 6, to July 29, 2003 in the eleven Sites of Community Importance of the Lodi Province (NW Italy, Fig. 1, Table 1).

A Systematic Sampling System (SSS; Scott, 1994) was adopted during this study; in each biotope we conducted sistematic research aimed at identifying species, location and their relative abundance. A period of 60 min was adopted as standard effort time and at least a research session was carried out weekly in each biotope from late March to late July. Species were identified by means of capture, direct

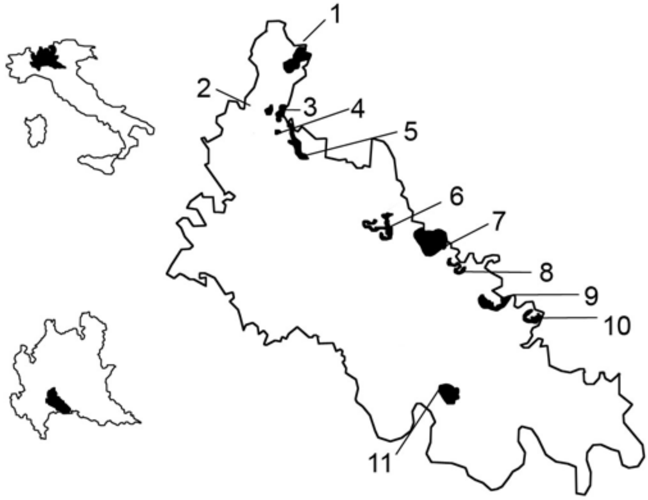

Fig 1. The eleven SCI surveyed: (1) Boschi e lanca di Comazzo, (2) Garzaia del Mortone, (3) Bosco del Mortone, (4) Garzaia della Cascina del Pioppo, (5) Spiagge fluviali di Boffalora , (6) Lanca di Soltarico, (7) La Zerbaglia, (8) Morta di Bertonico, (9) Adda Morta, (10) Bosco Valentino, (11) Monticchie.

Table 1. Locations, EU code and IGM coordinates and surface (in ha) of the 11 SCI under study.

SCI name	EU code	IGM coordinates	Area (ha)
1 Boschi e lanca di Comazzo	IT2090002	45°25'44.36"N; 9°27'48.69"E	267
2 Garzaia della Cascina del Pioppo	IT2090005	45°22'21.05"N; 9°26'49.85"E	6
3 Bosco del Mortone	IT2090003	45°23'17.17"N; 9°27'07.99"E	63
4 Garzaia del Mortone	IT2090004	45°23'21.43"N; 9°26'09.86"E	35
5 Spiagge fluviali di Boffalora	IT2090006	45°21'04.84"N; 9°28'34.60"E	172
6 Lanca di Soltarico	IT2090007	45°17'17.80"N; 9°35'04.21"E	170
7 La Zerbaglia	IT2090008	45°16'41.10"N; 9°38'25.85"E	552
8 Morta di Bertonico	IT2090009	45°15'17.92"N; 9°39'45.17"E	80
9 Adda Morta	IT2090011	45°13'17.80"N; 9°42'09.18"E	191
10 Bosco Valentino	IT2090011	45°12'34.20"N; 9°45'48.99"E	48
11 Monticchie	IT2090001	45°08'41.16"N; 9°39'27.91"E	238

observation, collection of dead individuals, shed skins pellets or scats analysys. The total sampling effort was 170 h; sampling effort was equally distributed among biotopes in relation to their area.

Relative abundance calculated by SSS was used in comparative analysis among species abundance. We calculated as richness (R) the number of species recorded during the study period in each biotope and as habitat eterogeneity a Shannon-Wiener index ($H=-\Sigma\ p_i \log p_i$) where p_i is is the proportion of the partial area of the habitat *i* on the total area of the biotope ($A_{habitat}/A_{biotope}$) and A is the area covered by each habitat and biotope. Data analysis were carried out by SPSS 10.1 package and Microsoft Excel. Relative surface of habitat, coordinates and EU codes for each SCI were obtained from the Regione Lombardia archive data.

RESULTS

Communities and local distribution

A total of seven species of amphibians (*Pelophylax* synkl. *esculenta, Pseudoepidalea viridis, Rana latastei, Bufo bufo, Hyla intermedia, Triturus carnifex, Lissotriton vulgaris*) and seven species of reptiles (*Podarcis muralis, Anguis fragilis, Lacerta bilineata, Hierophis viridiflavus, Natrix natrix, Natrix tessellata, Zamenis longissimus*) were recorded in our study areas; taxonomical attribution are from Frost et al. (2006).

Among amphibians *P.* synkl. *esculenta* is the most euritopic species and, together with *R. latastei, P. viridis* and *H. intermedia* are widely distributed in nearly all the study areas (Table 2); this data appeared of good conservation value, since *R. latastei* is an endemic species of the Po plain. The other amphibian species are irregularly distributed and newts were found only in few sites with permanent ponds (Table 2).

Among reptiles *P. muralis* and *N. natrix* are the most euritopic species and, together with *L. bilineata* and *H. viridiflavus*, are widely distributed, as showed by evennes index

Table 2. Local distribution of species. Evennes index showed how wide species distribution is (index range from 1 for euritopic species to 0 for stenotopic species).

	1 Boschi e lanca di Comazzo	2 Garzaia del Mortone	3 Bosco del Mortone	4 Garzaia della Cascina del Pioppo	5 Spiagge fluviali di Boffalora	6 Lanca di Soltarico	7 La Zerbaglia	8 Morta di Bertonico	9 Adda Morta	10 Bosco Valentino	11 Monticchie	Evennes
Pelophylax synkl. *esculenta*	+	+	+	+	+	+	+	+	+	+	+	1
Rana latastei	+	+	+		+	+	+	+	+	+	+	0.91
Pseudoepidalea viridis	+	+	+		+	+	+		+	+	+	0.82
Bufo bufo	+		+				+	+		+		0.45
Hyla intermedia	+		+			+		+	+	+	+	0.64
Triturus carnifex					+					+	+	0.27
Lissotriton vulgaris								+			+	0.18
Podarcis muralis	+	+	+	+	+	+	+	+	+	+	+	1
Lacerta bilineata	+	+	+		+	+	+	+	+	+	+	0.91
Anguis fragilis	+									+	+	0.27
Natrix natrix	+	+	+	+	+	+	+	+	+	+	+	1
Hierophis viridiflavus	+		+		+	+	+	+	+	+	+	0.82
Natrix tassellata					+	+		+	+		+	0.45
Zamenis longissimus							+					0.09

ranging form 1 to 0.82 in nearly all the study areas; the other species are irregularly distributed or strongly localized in a single biotope as Z. *longissimus* (Table 2).

Species detectability and abundance differences

The frequency of observation/recording was higher from April to June than in July, both for amphibians and reptiles. All amphibians were monthly detected from March to June while detectability of reptiles was slightly lower and not all species were found in the same period; observation rate slightly decreased in the last month of surveys for both taxa.

Data analysis showed remarkably differences in relative amphibians abundance (Fig. 2); the most widespread *P.* synkl. *esculenta* is the most abundant specie (mean = 25.5 ind/h), while abundance of *R. latastei*, despite its wide local distribution, is constantly less

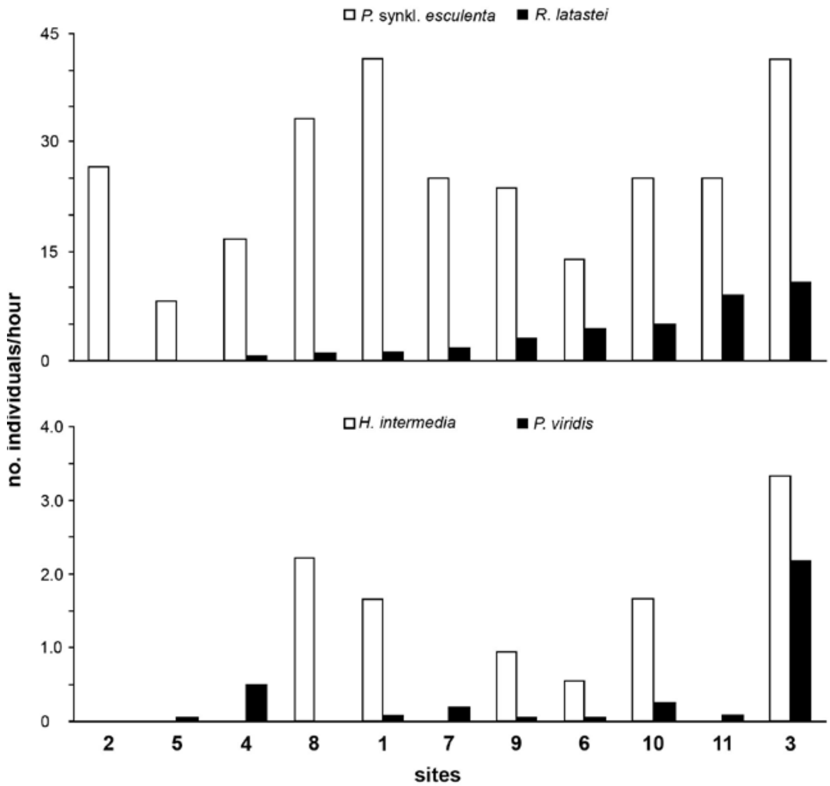

Fig. 2. Relative abundance of *Rana latastei*, *Pelophylax* synkl. *esculenta*, *Hyla intermedia* and *Pseudoepidalea viridis.*

abundant (mean = 3.18 ind/h). The abundance of the former species is apparently unrelated to habitat physiognomy, while *R. latastei* abundance increased to increasing of wooded areas (r_s = 0.82, n = 10, P = 0.03).

Abundance pattern showed by *H. intermedia* and *P. viridis*, the only other amphibian species for which enough data were collected, is somewhat erratic; *P. viridis* appeared a localised species with very scarce populations, while *H. intermedia* is more widely distributed, indipendently of the amount of wooded habitat (r_s = 0.44, n = 10, P = 0.20, Fig. 2).

Reptiles abundance appeared less variable; *Podarcis muralis* is the most abundant species in all the habitats and, together with *L. bilineata*, is widespread in the study area. Snakes are widely distributed, showing a very low relative population abundance (Fig. 3).

Relation between richness and habitat area and heterogeneity

Data showed that pooled species richness and biotope area were significantly and positively related (richness = 0.45 × Ln(area) + 0.63, R^2 = 0.73, P = 0.004; Fig. 4a), and furthermore that a significant relation existed considering richness of each individual group,

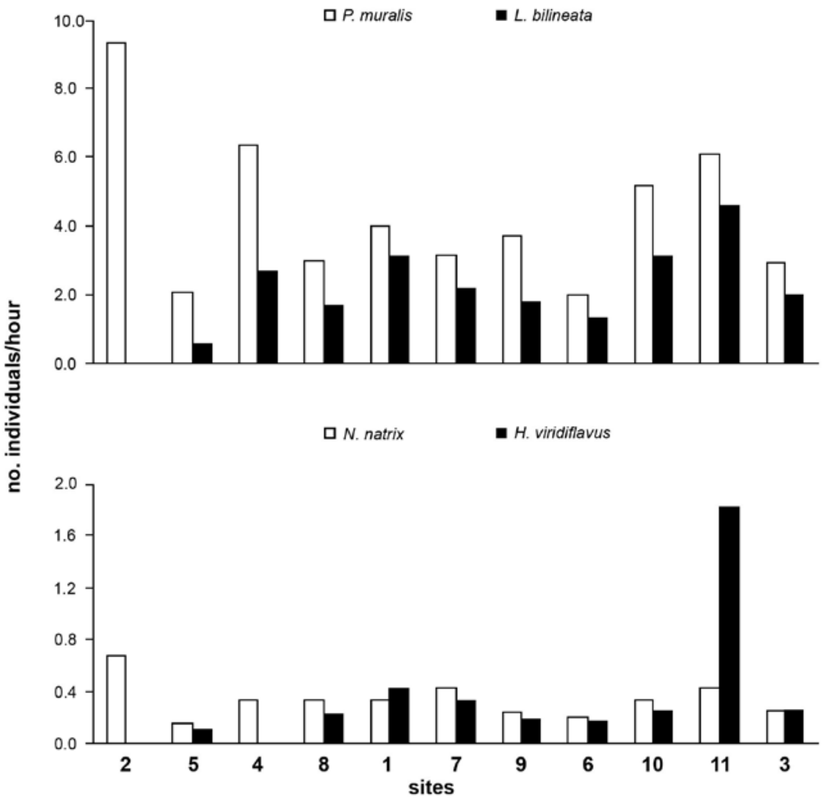

Fig. 3. Relative abundance of *Podarcis muralis*, *Lacerta bilineata*, *Natrix natrix* and *Hierophis viridiflavus.*

(i) amphibians (richness = 0.59 × Ln(area) + 0.23, R^2 = 0.69, P = 0.004), and (ii) reptiles (richness = 0.38 × Ln(area) + 0.39, R^2 = 0.72, P = 0.003).

Moreover, we observed a significant relation between pooled species richness and habitat diversity (richness = 0.45 × Ln(habitat diversity) + 1.11, R^2 = 0.58, P = 0.02), and that such relation was significant, thought with a lower predictive value, when considering separately amphibians (richness = 0.51 × Ln(habitat diversity) + 0.38, R^2 = 0.52, P = 0.027) and reptiles (richness = 0.34 × Ln(habitat diversity) + 0.78, R^2 = 0.47, P = 0.032, Fig. 4b).

DISCUSSION

Following previous research and surveys, the presence of nine amphibians and eleven reptile species had been verified in the southern Po plain (Lodi Province, Bernini et al., 2004a). During the current study *Pelobates fuscus* and *Rana dalmatina* were not recorded among amphibians, and *Emys orbicularis*, *Podarcis sicula*, *Coronella austriaca* and *Vipera aspis* among reptiles. In summary, current results showed that nearly 78% of known

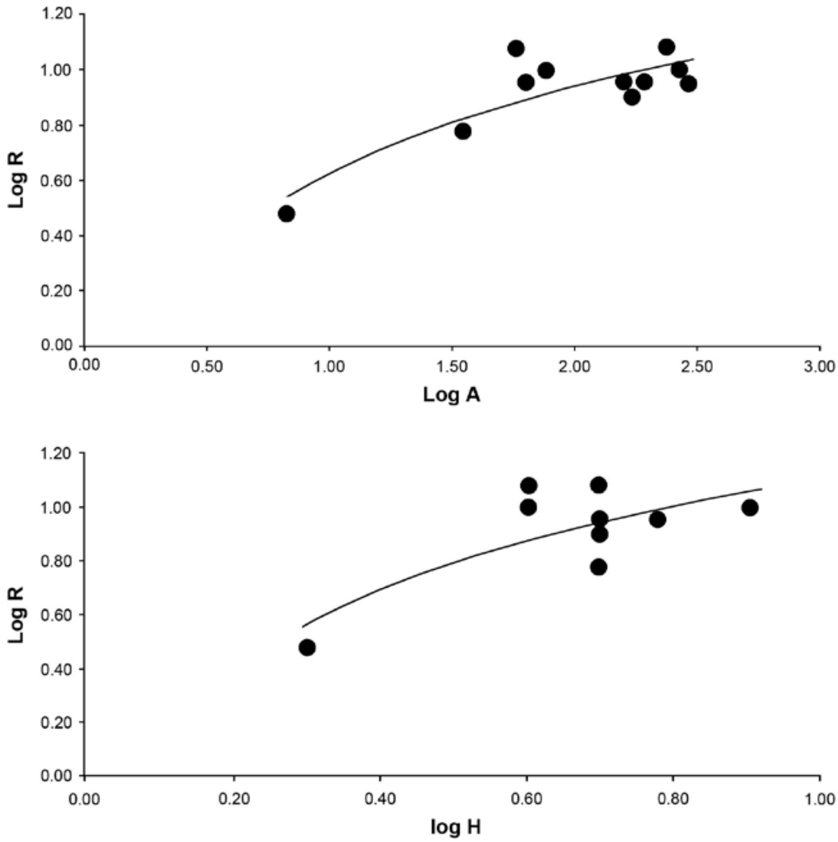

Fig. 4. Relation between richness (R) versus SCI area (above) and versus structural diversity (H) of biotopes (below) (data are log transformed).

amphibians and 63% of known reptiles are present in the SCI. This data can be interpreted in two alternative ways: first, SSS method might fails to detect the most elusive species or secondly, SSS method might reflect the actual relative abundances of species. The prevalence of unrecorded species among reptiles probably reflected both their local rarity (such as for *E. orbicularis;* Chelazzi et al., 2000; Ferri and Zuffi, 2004), low detectability (e.g. *C. austriaca*) as well as patterns of local distribution (*P. sicula* and *V. aspis* are known to be present in areas out of the current SCI network).

Species detectability is high during the spring season and showed a slight decrease in July, the warmer month; at our latitude the SSS method appeared to be more profitable in early spring than in summer (probably from late winter, i.e. February, for some species as *R. latastei* and *R. dalmatina* that are early breeders and this suggestion can be assumed as a methodological improvement at least for the Italian northern distributive area of the species under study.

Detailed analysis on population abundance are clearly precluded by speditive methods adopted during the presents study; only a few species as *P.* synkl. *esculenta* and *P. muralis* are relatively common. Relative abundance of other species as *P. viridis,* appeared lower than expected; in some sectors of the Po plain *P. viridis* is considered a declining species, as previously reported for some European populations (Honegger, 1981); the most common threaths to its conservation are identified in the reduction of temporary pond (Bonini and Bressi, 2004), and this can partially explain the reduction of the species' population over large areas. We suggest that a general reduction of ponds along the main course of a number of large rivers, and the late egg-laying period (May-June), can heavily influence the reproductive performances of *P. viridis* in the dry flood plain of the Adda river, an habitat dynamics not shared by other amphibian species which reproduced earlier.

Similar conditions are shared by *B. bufo*, apparently a species very scarce in our study areas, whose reduction could it be possibly influenced by the delayed effects of agricolture intensive practices (Pavignano and Giacoma, 1990).

The pattern of local distribution of some species, as *R. latastei*, appeared influenced by habitat physiognomy; the relative abundance of this species is significantly related to the area of wooded patches, a data confirming current informations on its ecology (Barbieri and Bernini, 2004a); in our study areas *R. latastei* is abundant in patches of ancient oak woodland (Bernini et al., 2004), characterized by high pond availability in early spring; if temporary ponds are available at the start/beginning of breeding season, the species can colonize poplar groves and seminatural wooded habitats.

Analysis of relation between community parameters and habitat size and physiognomy showed that SCI with wider/larger surfaces and higher habitat heterogeneity included an higher number of species. It is well known that biodiversity cannot be expressed only by richness index, since quantitative parameters as abundance and density, and genetic characteristics of populations should be taken into account as well; however richness index can be considered as a raw, sinthetic index of community quality. Since the significant positive relation between richness and habitat area, and heterogeneity is confirmed separately both for amphibians and reptiles, we suggest that, in planning of protected areas, priority must be retained for large and heterogeneous biotopes. In this framework, however, a passive protection scheme can be unsuitable to guarantee a safety level of protection for some species; more resources must be devoted in paying attention to both conservation measures and obtained results (Watzold and Schwerdtner, 2005).

Despite of the possible failure of SSS methodology in elusive species detection, we must take into account the actual function of Natura 2000 in protecting local biodiversity. Our data did not exclude that the establishment of a continental network of protected areas did not ensure a good level of conservation on local scale, at least for some species of reptiles. In this framework an higher effort in looking for additional spatial and biological indicators is then auspicable (Bock et al., 2005; Papageorgiou and Vogiatzakis, 2006).

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REFERENCES

Barbieri, F., Bernini, F. (2004): Distribution and status of *Rana latastei* in Italy (Amphibia, Ranidae). Ital. J. Zool. **71**: 91-94.

Bernini, F., Bonini, L., Ferri, V., Gentilli, A., Razzetti, E., Scali, S. (2004a): Atlante degli anfibi e dei rettili della Lombardia. Pianura, Monografie **5**, Cremona.

Bernini, F., Gentilli, A., Merli, E., Razzetti, E. (2004b): *Rana dalmatina* and *R. latastei*: habitat selection, fluctuation in egg clutch deposition and response to exceptional floods in Northern Italy. Ital. J. Zool **71**: 147-149.

Bock, M., Rossner, G., Wissen, M., Remm, K., Langanke, T., Lang, S., Klug, H., Blaschke, T., Vrscaj, B. (2005): Spatial indicators for nature conservation from European to local scale. Ecol. Ind. **5**: 322-338.

Bonini, L., Bressi, N. (2004): Rospo smeraldino. In: Atlante degli anfibi e dei rettili della Lombardia, p. 135-136. Bernini, F., Bonini, L., Ferri, V., Gentilli, A., Razzetti, E., Scali, S., Eds, Pianura, Monografie **5**, Cremona.

Bosch, J., Martinez-Solano, I. (2006): Chytrid fungus infection related to unusual mortalities of *Salamandra salamandra* and *Bufo bufo* in the Penalara Natural Park, Spain. Oryx **40**: 84-89.

Chelazzi, G., Lebboroni, M., Tripepi, S., Utzeri, C., Zuffi, M.A.L. (2000): A primer on the conservation biology of the European pond turtle *Emys orbicularis* of Italy. Chelonii **2**: 101-104.

Ernst, R., Lisenmair, K.E., Rodel, M.O. (2006): Diversity erosion beyond the species level: dramatic loss of functional diversity after selective logging in two tropical amphibian communities. Biol. Cons. **133**: 143-155.

Ferri, V., Zuffi, M. (2004): Testuggine palustre europea. In: Atlante degli anfibi e dei rettili della Lombardia, p. 117-119. Bernini, F., Bonini, L., Ferri, V., Gentilli, A., Razzetti, E., Scali, S., Eds, Pianura, Monografie **5**, Cremona.

Freemark, K.E., Meyers, M., White, D., Warman, L.D., Kiester, A.R., Lumban-Tobing, P. (2006): Species richness and biodiversity conservation priorities in British Columbia, Canada. Can. J. Zool. **84**: 20-31.

Frost, D.R., Grant, T., Faivovich, J., Bain, R.H., Haas, A., Haddad, C.F.B., De Sà, R.O., Channing, A., Wilkinson, M., Donnellan, S.C., Raxworthy, C.J., Campbell, J.A., Blotto, B.L., Moler, P., Drewes, R.C., Nussbaum, R.A., Lynch, J.D., Green, D.M., Wheeler, W.C. (2006): The amphibian tree of life. Bull. Am. Mus. Nat. Hist. **297**: 1-371.

Garcia, A. (2006): Using ecological niche modelling to identify diversity hotspots for the herpetofauna of Pacific lowlands and adjacent interior valleys of Mexico. Biol. Cons. **133**: 25-46.

Honegger, R.E. (1981): Threatened amphibians and reptiles in Europe. In: Handbuch der Reptilien und Amphibien Europas, p. 158-159. Böhme, W., Ed, AULA-Verlag, Wiesbaden.

Lebboroni, M., Ricchiardino, G., Bellavita, M., Chelazzi, G. (2006): Potential use of Anurans as indicators of biological quality in upstreams of central Italy. Amphibia-Reptilia **27**: 73-79.

Krebs, C.J. (2001): Ecology: The experimental analysis of distribution and abundance. Benjamin/Cummings, Philadelphia.

Papageorgiou, K., Vogiatzakis, L.N. (2006): Nature protection in Greece: an appraisal of the factors shaping integrative conservation and policy effectiveness. Env. Sci. Pol. **9**: 476-486.

Pavignano, I., Giacoma, C. (1990): A multivariate analysis of amphibian habitat determinants in north western Italy. Amphibia-Reptilia **11**: 311-324.

Pounds, J.A., Bustamante, M.R., Coloma, L.A., Consuegra, J.A., Fogden, M.P.L., Foster, P.N., La Marca, E., Masters, K.L., Merino-Viteri, A., Puschendorf, R., Ron, S.R., Sanchez-Azofeifa, G.A., Still, C.J., Young, B.E. (2006): Widespread amphibian extinctions from epidemic disease driven by global warming. Nature **439**: 161-167.

Rachowicz, L.J., Knapp, R.A., Morgan, J.A.T., Stice, M.J., Vredenburg, V.T., Parker, J.M., Briggs, C.J. (2006): Emerging infectious disease as a proximate cause of amphibian mass mortality. Ecology **87**: 1671-1683.

Rondinini, C., Boitani, L. (2006): Differences in the umbrella effects of African amphibians and mammals based on two estimators of the area of occupancy. Cons. Biol. **20**: 170-179.

Russell, K.R., Hanlin, H.G., Wigley, T.B., Guynn, D.C. (2002): Responses of isolated wetland herpetofauna to upland forest management. J. Wild. Manag. **66**: 603-617.

Ryan, T.J., Philippi, T., Leiden, Y.A., Dorcas, M.E., Wigley, T.B., Gibbons, J.W. (2002): Monitoring herpetofauna in a managed forest landscape: effects of habitat types and census techniques. Forest Ecol. Manag. **167**: 83-90.

Scott, J. (1994): Complete species inventories. In: Measuring and monitoring biological diversity. Standard method for amphibians, p. 78-84. Heyer, R.W., Donnelly, M.A., McDiarmid, R.W., Hayek, L.A.C., Foster, M.S., Eds, Smithsonian University Press, Washington.

Stenseth, N.C. (1989): On the evolutionary ecology of mammalian communities. In: Patterns of the structure of mammalian communities, p. 219-229. Morris, D.W., Abramsky, Z., Fox, B.J., Willig, M.R., Eds, Texas Tech Univ. Press, Lubbock.

Watzold, F., Schwerdtner, K. (2005): Why be wasteful when preserving a valuable resource? A review article on the cost-effectiveness of European biodiversity conservation policy. Biol. Cons. **123**: 327-338.

Webb, S.D. (1989): The fourth dimension in North American terrestrial mammal communities. In Patterns of the structure of mammalian communities, p. 181-203. Morris, D.W., Abramsky, Z., Fox, B.J., Willig, M.R., Eds, Texas Tech. Univ. Press, Lubbock.