

of calling sites among the four species. For example, *E. brittoni* and *E. juanariveroi* are small species that call from the tips of the vegetation. High temperatures and intense precipitation may cause them to retreat into the vegetation and reduce calling activity. In contrast, *E. coqui* and *E. cochranæ* call lower in the vegetation and from leaf axils where they are more protected. Based on these findings, future scenarios of climate change could pose a threat for the survival of the populations of these four species. New climate regimes could negatively affect the calling activity, and thus diminish reproductive events.

O. E. Ospina, L. J. Villanueva-Rivera, C. J. Corrada-Bravo, T. M. Aide, *Ecosphere* 4, 47 (2013).

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### A quantitative assessment of the conservation benefits of the Wetlands Reserve Program to amphibians

By Hardin Waddle, Brad M. Glorioso & Stephen P. Faulkner

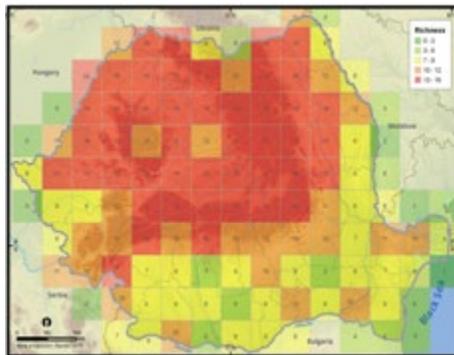
Although the Mississippi Alluvial Valley (MAV) originally consisted of nearly 10 million hectares of contiguous bottomland hardwood (BLH) forest, only 20–25% of the historical BLH forests currently remain. Most of the remnant BLH is in small patches surrounded by agricultural lands. The Wetlands Reserve Program (WRP) was established to provide for the restoration and protection of the functions and values of wetlands in agricultural landscapes. We surveyed 30 randomly selected WRP sites and 20 adjacent agricultural sites in the Mississippi Delta region of northwest Mississippi to assess the potential benefit of WRP restoration for amphibian populations. We sampled during repeat visits to each site from May through August 2008 and performed visual encounter and vocalization surveys. We analyzed observation data for the 11 anuran species encountered using a Bayesian hierarchical occupancy model that simultaneously



The Southern leopard frog (*Lithobates sphenoccephalus*) was one of the frog species that appeared to benefit from WRP restoration in the Mississippi Delta. Photo: Brad Glorioso.

estimated probability of occurrence and detection probability for each individual species. Nine of the amphibian species had higher probabilities of occurrence at WRP sites relative to agriculture. Species richness estimates were also higher at WRP sites. Five of the species were significantly more likely to occur at WRP sites than at agriculture sites; four of which were among the most aquatic species of anurans we encountered. We conclude that hydrologic restoration at the WRP sites may be providing suitable habitat for more species than any single agricultural site. Amphibians are useful for evaluating restoration benefits for wildlife because of their intermediate trophic position, and their dependence on hydrology to complete their life cycle make them ideal for evaluating the benefits of wetland restoration.

H. Waddle, B. Glorioso, S. Faulkner, *Restor. Ecol.* 21, 200 (2013).



Amphibian species richness within Romania at a 50 × 50 km grid resolution. Credit: D. Cogălniceanu et al., 2013.

### Diversity and distribution of amphibians in Romania

By Dan Cogălniceanu, Paul Székely, Ciprian Samoilă, Iosif Ruben, Marian Tudor, Rodica Plăiașu, Florina Stănescu & Laurențiu Rozyłowicz

Many countries do not usually provide quality distribution data due to less uniform and intensive recording effort. Sixty percent of the papers on Amphibians of Romania had been published after 2000. Despite this substantial increase in the inventory effort in Romania, there was no updated available distribution database, nor a published atlas. Nineteen species of amphibians inhabit Romania, of which nine reach here their range limit. To map their distribution, we georeferenced 26,779 amphibian species occurrences, and performed a spatial patterns analysis, checking for hotspots and patterns in species richness. The results of spatial statistics analyses indicate a biased sampling for Romania, with hotspots of sampling efforts clearly delineated. The

sampling effort is biased towards species with high detectability, protected areas, and large cities. The incomplete and biased species inventory in Romania may have several causes: difficult access due to low road density, complex landscape (with 15% of the territory above 800 m), limited funds available for large-scale inventory and monitoring projects, and lack of institutional support. The future sampling effort should be focused mostly on species with a high rarity score in order to accurately map their range. The geospatial database and outputs presented in this paper as occurrence records fill a gap in our knowledge. In addition, our mapping exercise may allow future predictions of species range shifts under climate change scenarios, as well as prioritization of conservation efforts and identification of important conservation areas for amphibians.

D. Cogălniceanu et al., *ZooKeys* 296, 35 (2013). doi: 10.3897/zookeys.296.4872.

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### Anuran amphibians as indicators of changes in aquatic and terrestrial ecosystems following GM crop cultivation: a monitoring guideline

By Susanne Böll, Benedikt R. Schmidt, Michael Veith, Norman Wagner, Dennis Rödder, Cathrin Weimann, Tom Kirschey & Stefan Lötters

Amphibians are a suitable indicator group for monitoring possible negative direct or indirect effects of GMO cultivation at the individual and population level. Direct effects could occur in aquatic ecosystems via uptake of GM pollen or GM detritus by anuran larvae. However, indirect negative effects caused by changes in cultivation practices (changes in pesticide use, for instance) are more likely. The VDI Guideline 4333 aims to ensure comprehensive monitoring of the different life-stages of anuran species that are common in agricultural landscapes of Austria, Germany and Switzerland. The guideline includes a novel approach to tadpole monitoring. To assess immediate effects, tadpole, metamorph and adult deformation rates are compared with naturally occurring deformation rates. Adult population size, adult body condition and juvenile emergence are monitored over multiple years to assess long-term effects of GM crop cultivation on population viability. At each study site, monitoring has to be carried out at multiple amphibian breeding sites which differ in their exposure to GM crop cultivation. All monitoring data have to be stored in a central database for future meta-analyses. This will ultimately allow for generalized statements about the impact of GM crop cultivation on amphibians. Although specifically designed for GM