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Short Communication

Habitat degradation and biological invasions as a cause of amphibian richness loss: a case report in Aceguá, Cerro Largo, Uruguay

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Habitat loss and fragmentation are primary causes of biodiversity loss and ecosystem degradation at the global level (Wu 2013, Ceballos *et al.* 2015). In this context, wetlands are one of the most threatened systems, with a significant rate of change associated with urbanization and land use for agricultural purposes. Amphibians are one of the most affected groups by wetlands loss (Mendenhall *et al.* 2014) and therefore the IUCN global action plan places special emphasis on the conservation of these environments (Gascon *et al.* 2007). Wetland degradation has been widely reported in the northern hemisphere at different scales, but it has been poorly evaluated in the Neotropical region (Davidson 2014).

The present study was carried out at Aceguá, Cerro Largo Department, Uruguay, in the pampas region of South America. This hilly area consists of a watershed that divides the basins of Laguna Merín lagoon and the Río Negro. This zone, located close to the border of Brazil, is home to a rich native biodiversity, so its conservation is a national priority (Di Minin *et al.* 2017). Although this area has been little affected by intensive agriculture, the rapid advance of the agricultural frontier is an imminent threat. In addition, the native anuran diversity of Aceguá (Laufer *et al.* 2009, Gobel *et al.* 2013) is threatened by the recent invasion of the American Bullfrog, *Lithobates catesbeianus* (Shaw, 1802) (Ruibal and Laufer 2012, Laufer *et al.* 2017a). This large aquatic anuran, native to eastern North America, has been introduced for aquaculture in several regions, becoming one of the most dangerous global invaders associated with the amphibian decline phenomenon (Lowe *et al.* 2000). Bullfrogs negatively affect native anurans by predation, competition and disease introduction (reviewed by Kraus 2009).

Here we report a case in which the structure of a small wetland and its surrounding area (70,000 m^2) located on a private farm was strongly altered (31°53'17" S, 54°09'52" W, 238 m a.s.l.). Beginning in January 2014 the flooded

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areas were drained, and the emergent aquatic vegetation and surrounding plants and shrubs were removed. This alteration continued until 2015, when the area was transformed into artificial grassland with two small water reservoirs (Figure 1). During this process, the complexity of microenvironments generated by plant diversity and heterogeneity was lost, affecting the great abundance of *Eryngium* L., *Eupatorium* L., *Baccharis* L., and small shrubs.

Unaware that this intervention would be carried out, we performed two amphibian surveys at the area (on 22 October 2012 and 02 December 2013). After the intervention we continued annual sampling under the same conditions until 2016 (01 December 2014, 09 December 2015 and 18 December 2016). Amphibian search effort was standardized to 20 min per visit using a slow-paced transect around the wetland perimeter (21:00 to 23:00 hrs, in non rainy nights, 18 to 21°C; Laufer *et al.* 2017b). The sampling was performed by three expert researchers, who, during the wetland border survey, recorded the presence of anuran species through direct sighting and/or listening to nuptial calls. Specific richness was the total number of species observed or heard at the system over the visit. It should be noted that the effort in the first year (2012) was shorter in time and transect length, approximately half the other samples. Data from all years was included, considering the value of monitoring the habitat degradation in this area. Bullfrogs, which were present in some nearby ponds, invaded this system immediately after the intervention, rapidly increasing its abundance in the following years (Figure 2A). The increase of the abundance of this invasive species was faster than we observed in the nearby systems (personal observations). Agricultural activities are one of the most severe disturbances that promote colonization and establishment of invasive species (Chytrý *et al.* 2012).

We observed 14 native anuran species in the system; 12 of them were recorded during the first two years, before the intervention (Table 1).

Figure 1. Sequence of degradation of a small wetland in Aceguá, Cerro Largo Department, Uruguay. Google Earth images show the state of the system in 2007, which was maintained until January 2014, when the degradation process began, and continued until 2015.

Table 1. Sampling of anuran species in a small wetland in Aceguá, Cerro Largo Department, Uruguay. The species list includes the habitat type (ground level, on shrubs or in water) and the year in which each one was observed. The *indicates the year with a minor sampling effort.

Species	Habitat	2012*	2013	2014	2015	2016
Boana pulchella (Duméril and Bibron, 1841)	shrub	x		x	x	
Dendropsophus minutus (Peters, 1872)	water				x	
Dendropsophus sanborni (Schmidt, 1944)	water	x	x		x	
Elachistocleis bicolor (Guérin-Méneville, 1838)	ground	x	x			
Julianus uruguayus (Schmidt, 1944)	shrub	x	x	x		
Leptodactylus gracilis (Duméril and Bibron, 1840)	ground		x			
Leptodactylus latinasus Jiménez de la Espada, 1875	ground			x		
Leptodactylus latrans (Steffen, 1815)	ground	x	x	x	x	x
Lithobates catesbeianus (Shaw, 1802) (exotic)	water			x	x	x
Phyllomedusa iheringii Boulenger, 1885	shrub		x			
Physalaemus riograndensis Milstead, 1960	water		x			
Pseudopaludicola falcipes (Hensel, 1867)	ground	x				
Pseudis minuta Günther, 1858	water	x	x		x	
Scinax granulatus (Peters, 1871)	shrub		x			
Scinax squalirostris (Lutz, 1925)	shrub		x			

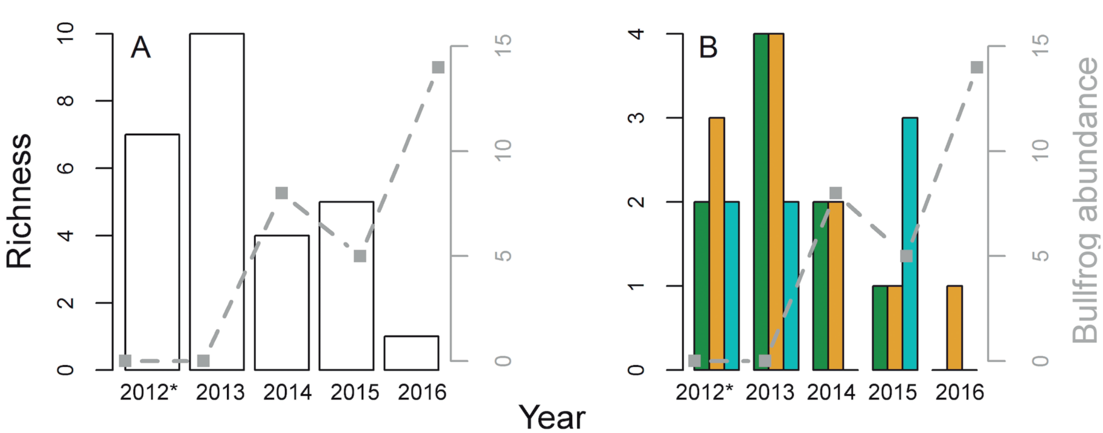

Figure 2. Amphibian richness in a degradation sequence of a small wetland in Aceguá, Cerro Largo Department, Uruguay. The * indicates the year with a minor sampling effort. Gray dots indicate the invasive American bullfrog abundance. (**A**) Total number of native anuran species recorded in a standardized sampling. (**B**) Native anuran richness for the different habits groups (green = shrub, yellow = ground, blue = water) (see Table 1).

After the intervention, a sharp fall in the number of native species was recorded. Only a single species, *Leptodactylus latrans* (Steffen, 1815), was observed in 2016. *Leptodactylus latrans* is a large generalist anuran that is widely distributed and probably could tolerate bullfrog presence (Silva *et al.* 2016).

Considering a simple classification of native species according to the habitats in which they occurred—in shrubs, on the ground or in water (Table 1)—we observed that amphibians inhabiting shrubs and occurring on the ground rapidly decreased in richness after the disturbance (Figure 2B). This fall in diversity was probably due to the disappearance of the surrounding vegetation and shallow water (Figure 1). Aquatic amphibians persisted, probably due to the persistence of their aquatic habitat. The evidence suggests that these aquatic species should be affected only slightly by direct predation in subsequent years because of their habits (Kraus 2009). Therefore, disturbance could be structuring the wetland community, negatively affecting native species and accelerating bullfrog invasion.

In summary, we found that two strong forces of global change (habitat destruction and invasive species) were detrimental to the richness of native anurans. These two forces could be acting in synergy on the assembly of native anurans (Bucciarelli *et al.* 2014). Additional documentation of cases of these phenomena in the Neotropics should lead to a better understanding the interaction of land use and biological invasions on native anurofauna.

Wetlands are declining significantly in Uruguay and the surrounding region (Tiscornia *et al.* 2004, Baldi and Paruelo 2008), and their conservation is crucial for survival of native anurans. Considering that protected areas cover only 17% of the world's land area (Ellis *et al.* 2010) and less than 1% in Uruguay (MVOTMA 2015), the conservation of biodiversity will depend on the management of private lands (Mendenhall *et al.* 2014, 2016). Future degradation associated with land use should be monitored and good practices encouraged.

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References

Baldi, G. and J. M. Paruelo. 2008. Land-use and land cover dynamics in South American temperate grasslands. *Ecology and Society 13:* 6.

Bucciarelli, G. M., A. R. Blaustein, T. S. Garcia, and L. B. Kats. 2014. Invasion complexities: the diverse impacts of nonnative species on amphibians. *Copeia 2014:* 611–632.

Ceballos, G., P. R. Ehrlich, A. D. Barnosky, A. García, R. M. Pringle, and T. M. Palmer. 2015. Accelerated modern human-induced species losses: entering the sixth mass extinction. *Science Advances 1:* e1400253.

Chytrý, M., J. Wild, P. Pyšek, V. Jarošík, N. Dendoncker, I. Reginster, J. Pino, L. C. Maskell, M. Vila, J. Pergl, I. Kühn, J. H. Spangenberg, and J. Settele. 2012. Projecting trends in plant invasions in Europe under different scenarios of future land-use change. *Global Ecology and Biogeography 21:* 75–87.

Davidson, N. C. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research 65:* 934–941.

Di Minin, E., A. Soutullo, L. Bartesaghi, M. Rios, M. N. Szephegyi, and A. Moilanen. 2017. Integrating biodiversity, ecosystem services and socio-economic data to identify priority areas and landowners for conservation actions at the national scale. *Biological Conservation 206:* 56–64.

Ellis, E. C., K. K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology Biogeography 19:* 589–606.

Gascon, C., J. P. Collins, R. D. Moore, D. R. Church, J. E. McKay, and J. R. Mendelson III. 2007. *Amphibian*

Conservation Action Plan. Proceedings: IUCN/SSC Amphibian Conservation Summit 2005. Gland. IUCN/ Species Survival Commission, Amphibian Specialist Group. 64pp.

Gobel, N., S. Cortizas, J. M. Mautone, C. Borteiro, and G. Laufer. 2013. Predation of *Pseudis minuta* Günther 1858, by *Lethocerus annulipes* (Heteroptera: Belostomatidae). *Cuadernos de Herpetología 27:* 63.

Kraus, F. 2009. *Alien Reptiles and Amphibians: A Scientific Compendium and Analysis.* New York. Invading Nature-Springer Series In Invasion Ecology. Springer. 576 pp.

Laufer, G., N. Gobel, C. Borteiro, A. Soutullo, C. Martinez-Debat, and R. de Sá. 2017a. Current status of American bullfrog, *Lithobates catesbeianus,* invasion in Uruguay and exploration of chytrid infection. *Biological Invasions:* 1–7.

Laufer, G., N. Gobel, A. Soutullo, C. Martinez-Debat, and R. de Sá. 2017b. Assessment of the calling detection probability throughout the day of two invasive populations of bullfrog (*Lithobates catesbeianus*) in Uruguay. *Cuadernos de Herpetología 31:* 29–32.

Laufer, G., J. M. Piñeiro-Guerra, R. Pereira-Garbero, J. M. Barreneche, and R. Ferrero. 2009. Distribution extension of *Scinax aromothyella* (Anura, Hylidae). *Biota Neotropica 9:* 275–277.

Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2000. *100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database.* Auckland. IUCN/Species Survival Commission, Invasive Species Specialist Group. 12 pp.

Mendenhall, C. D., L. O. Frishkoff, G. Santos-Barrera, J. Pacheco, E. Mesfun, F. M. Quijano, P. R. Ehrlich, G. Ceballos, G. C. Daily, and R. M. Pringle. 2014. Countryside biogeography of Neotropical reptiles and amphibians. *Ecology 95:* 856–870.

Mendenhall, C. D., A. Shields-Estradaa, A. J. Krishnaswami, and G. C. Daily. 2016. Quantifying and sustaining biodiversity in tropical agricultural landscapes. *PNAS 113:* 14544–14551.

MVOTMA. 2015. *Plan Estrategico 2015–2020. Sistema Nacional de* Áreas *Protegidas de Uruguay.* Montevideo. Ministerio de Vivienda, Ordenamento Territorial y Medio Ambiente. 60 pp.

Ruibal, M. and G. Laufer. 2012. Bullfrog *Lithobates catesbeianus* (Amphibia: Ranidae) tadpole diet: description and analysis for three invasive populations in Uruguay. *Amphibia-Reptilia 33:* 355–363.

Silva, E. T., C. Both, and O. P. Ribeiro Filho. 2016. Food habits of invasive bullfrogs and native thin-toed frogs occurring in sympatry in southeastern Brazil. *South American Journal of Herpetology 11:* 25–33.

Tiscornia, G., M. Achkar, and A. Brazeiro. 2014. Efectos de la intensificación agrícola sobre la estructura y diversidad del paisaje en la región sojera de Uruguay. *Ecologia Austral 24:* 212–219.

Wu, J. G. 2013. Key concepts and research topics in landscape ecology revisited: 30 years after the Allerton Park workshop. *Landscape Ecology 28:* 1–11.

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