

Supplementary Material

Amphibian taxonomic and functional diversity in a heterogeneous landscape of west-central Mexico

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Table S1. Structural habitat variables measured on the amphibian's land cover/use plots.

Note: Plus sign (+) corresponds to the predictive variable eliminated by its high collinearity with a Pearson correlation ($r \geq 0.9$), while asterisks (*) represent all variables considered in DistLM and dbRDA.

Variable	Code	Description of variable
Percentage of herbaceous cover*	CH	0%, minimum percentage 100%, maximum percentage
Percentage of shrub cover*	CS	0%, minimum percentage 100%, maximum percentage
Percentage of tree cover*	CT	0%, minimum percentage 100%, maximum percentage
Rock*	R	0, no rocks 1, a few rocks 2, a rock every 20 m 3, several rocks every 20 m 4, very abundant one rock every 1 to 3 m
Stone*	S	0, no stones 1, a few stones 2, a stone every 20 m 3, several stones every 20 m 4, very abundant one stone every 1 to 3 m
Leaf litter*	H	0, no litter 1, very disperse litter with no little layer 2, layer less than 5 cm in depth 3, layer with a deep between 5 to 10 cm 4, layer deep more than 10 cm
Fire*	F	0, no signal of fire 1, a signal of fire but no more than 50 cm in height 2, a signal of fire between 50 cm and 1m

		3, a signal of fire up to 1m, young dead trees
		4, a signal of fire more than 1m, young trees dead and some adult ones
Cow grazing*	CG	0, no cow grazing
		1, very dispersed feces and footprints
		2, feces and footprints every 50 m
		3, feces and footprints less than 50 m
		4, abundant feces and footprints and a clear road made by cattle
Water*	W	1, near a pool
		2, near a stream
		3, far from a water body
Weather ⁺	We	T, temperate
		W, tropical

Table S2. Functional traits used in this study and their ecological meaning. A = Categorical data, U = Quantitative data.

Type of functional trait/ Data type	Trait attributes	Ecosystem relationship	References
Reproductive			
Reproductive mode (A)	1. Eggs laid and developed in water 2. Eggs laid outside the water, on vegetation at the edge of water bodies 3. Eggs laid outside the water, on the ground, and larvae developed within the egg 4. Eggs laid on foam nest	Strategy and reproductive success and habitat use	Díaz-García et al. [1]
Habitat related			
Diet (A)	1. Small invertebrates 2. Small and medium-sized invertebrates 3. Invertebrates and small vertebrates (like frogs) 4. Generalist (invertebrates and vertebrates) 5. Termites and ants	Recycling of nutrients and energy flow through food webs as predators.	Cortés-Gómez et al. [2]
Period of activity (A)	1. Diurnal 2. Diurnal-nocturnal	Differential contribution of matter and energy in time	Cortés-Gómez et al. [2]
Microhabitat (A)	1. Trees, shrubs, water 2. Water, rocks, and herbaceous vegetation near water	Differential contribution of matter and energy in space	Díaz-García et al. [1]

	3. Litter, under rocks, edge of water bodies		
Morphological			
Size (U)	Mean length rostrum-cloaca	Recycling of nutrients and energy flow through food webs as predator or prey	Cortés-Gómez et al. [2]
Skin (A)	1. Smooth 2. Tuberculated 3. Pustulated	Resistance to drying and hydrodynamic	Cortés-Gómez et al. [2]
Dorsal pattern (A)	1. Numerous spots with variable shapes and sizes 2. Regular oval spots and two dorsolateral yellow lines 3. Homogeneous but possibly with dark spots, with a homogeneous lateral stripe 4. Green reticulated with a reticulated lateral dark stripe 5. Homogeneous green with isolated white dots	Differential use of space, predation, and anti-predatory strategies	Álvarez-Grzybowska et al. [3]
Toxicity (A)	1. Toxic 2. Non-toxic	Nutrient recycling and energy flow through the trophic web	Cortés-Gómez et al. [2]

Table S3. Amphibian species recorded in the study area by land cover/use and protection category. Codes: sugar cane field (CA), riparian habitat surrounded by crops (RH-C), cornfield (CO), highly perturbed tropical dry forest (HPTDF), tropical dry forest (TDF), riparian habitat surrounded by tropical dry forest (RH-TDF), riparian habitat surrounded temperate forest (RH-TF), secondary vegetation surrounded by temperate forest (SV-TF), oak forest (OF) and pine-oak forest (POF).

Family/Species	Code	Endemism	Nom-059-2010	CA	RH-C	CO	HPTDF	TDF	RH-TDF	RH-TF	SV-TF	OF	POF
Craugastoridae													
<i>Craugastor hobarthsmithi</i>	Crho	E			X	X	X	X					
<i>Craugastor occidentalis</i>	Croc	E				X		X	X	X	X	X	X
<i>Craugastor augusti</i>	Crau						X	X	X	X	X	X	X
Eleutherodactylidae													
<i>Eleutherodactylus sp.</i>	Elpe	E		X	X	X	X		X	X			
Bufonidae													
<i>Incilius occidentalis</i>	Inoc	E									X	X	X
<i>Rhinella horribilis</i>	Rhho			X		X	X		X				
Hylidae													
<i>Exerodonta smaragdina</i>	Exsm	E	Pr								X		
<i>Dryophytes arenicolor</i>	Drar							X	X	X	X		
<i>Dryophytes eximius</i>	Drex	E							X		X		
<i>Sarcohyala hapsa</i>	Saha	E	Pr							X			
Leptodactylidae													
<i>Leptodactylus melanonotus</i>	Leme			X	X				X				
Microhylidae													
<i>Hypopachus variolosus</i>	Hyva								X				
Phyllomedusidae													
<i>Agalychnis dacnicolor</i>	Agda	E			X								
Ranidae													

<i>Rana cf. forreri</i>	Rafo	Pr					X		
<i>Rana neovolcanica</i>	Rane	E	A	X	X		X	X	X
Scaphiopodidae									
<i>Spea multiplicata</i>	Spmu						X		

Table S4. Abundance-based diversity of orders $q = 0, 1$, and 2 for the amphibian assemblage per site in a heterogeneous land cover/use landscape in western-central Mexico. Maximum standardized coverage $C_{\max} = 93\%$. Codes: sugar cane field (CA), riparian habitat surrounded by crops (RH-C), cornfield (CO), highly perturbed tropical dry forest (HPTDF), tropical dry forest (TDF), riparian habitat surrounded by tropical dry forest (RH-TDF), riparian habitat surrounded temperate forest (RH-TF), secondary vegetation surrounded by temperate forest (SV-TF), oak forest (OF) and pine-oak forest (POF).

(A) Sample completeness profiles			
Completeness	$q = 0$ (%)	$q = 1$ (%)	$q = 2$ (%)
CA	100	100	100
RH-C	83	98	100
CO	100	100	100
HPTDF	75	88	95
TDF	80	92	95
RH-TDF	56	88	99
RH-TF	83	94	75
SV-TF	100	100	100
OF	80	84	89
POF	100	100	100
(B) Asymptotic analysis			
Diversity	$q = 0$	$q = 1$	$q = 2$
CA			
Asymptotic	4	3.08	2.49
Observed	4	2.93	2.38
Undetected	0	0.15	0.11
RH-C			
Asymptotic	5.49	2.35	1.69
Observed	5	2.26	1.67
Undetected	0.49	0.09	0.02
CO			
Asymptotic	4	4.37	4.88

Observed	4	3.86	3.76
Undetected	0	0.51	1.12
HPTDF			
Asymptotic	7.87	6.69	6.18
Observed	6	5.15	4.59
Undetected	1.87	1.54	1.59
TDF			
Asymptotic	4.45	4.15	3.93
Observed	4	3.46	3.1
Undetected	0.45	0.69	0.83
RH-TDF			
Asymptotic	17.76	9.36	6.68
Observed	10	7.22	5.7
Undetected	7.76	2.14	0.98
RH-TF			
Asymptotic	5.11	6.3	9
Observed	5	4.86	4.76
Undetected	0.11	1.44	4.24
SV-TF			
Asymptotic	7	3.61	2.29
Observed	7	3.45	2.25
Undetected	0	0.16	0.04
OF			
Asymptotic	4.9	4.18	3.75
Observed	4	3.3	2.94
Undetected	0.9	0.88	0.81
POF			
Asymptotic	3	2.57	2.29
Observed	3	2.36	2.09
Undetected	0	0.21	0.20
SV-TF			

Asymptotic	7	3.61	2.29
Observed	7	3.45	2.25
Undetected	0	0.16	0.04

(C) Species evenness

	Pielou (J')	q = 1	q = 2
CA	0.79	0.675	0.492
RH-C	0.94	1	0.266
CO	0.59	0.369	0.809
HPTDF	0.91	0.811	0.696
TDF	0.90	0.840	0.700
RH-TDF	0.82	0.598	0.422
RH-TF	0.65	0.965	0.943
SV-TF	0.97	0.442	0.241
OF	0.85	0.740	0.609
POF	0.81	0.708	0.557

Table S5. Results of the DistLM marginal and sequential tests to obtain the best predictable model between amphibian species composition and environmental variables across land cover/use types.

(A) Marginal tests					
Variable	Pseudo-F	P	Explained variation proportion		
Percentage of tree cover	2.165	0.112	0.213		
Percentage of scrub cover	0.788	0.525	0.090		
Percentage of herbaceous cover	7.873	0.0004	0.496		
Rock	2.652	0.066	0.248		
Stone	2.531	0.080	0.240		
Leaf litter	1.328	0.280	0.142		
Fire	0.560	0.713	0.065		
Cow grazing	1.307	0.295	0.140		
Water	1.390	0.265	0.148		
(B) Sequential test					
Variable	R ² _{Adj}	Pseudo-F	P	Explained variation proportion	Cumulative variation (%)
Percentage of herbaceous cover	0.433	7.8731	0.0005	0.496	49.6
Cow grazing	0.589	4.0314	0.0126	0.184	68.0
Water	0.723	4.3732	0.0375	0.135	81.5

References

1. Díaz-García, J.M.; Pineda, E.; López-Barrera, F.; Moreno, C. E. Amphibian species and functional diversity as indicators of restoration success in tropical montane forest. *Biodivers. Conserv.* **2017**, *26*, 2569-2589. <https://doi.org/10.1007/s10531-017-1372-2>
2. Cortés-Gómez, A. M.; Ramírez, P. M. P.; Urbina C. N. Protocolo para la medición de rasgos funcionales en anfibios. In *La ecología funcional como aproximación al estudio, manejo y conservación de la biodiversidad: protocolos y aplicaciones*, Salgado-Negret, B., Ed.; Instituto de Investigación de Recursos Biológicos Alexander von Humboldt: Bogotá, D. C., Colombia, 2015; pp. 127- 179.
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