

Landscape predictors of the genetic diversity and differentiation of four anuran species inhabiting anthropized environments

Gerardo J. Soria-Ortiz, Ella Vázquez-Domínguez

Supplementary information

Figures

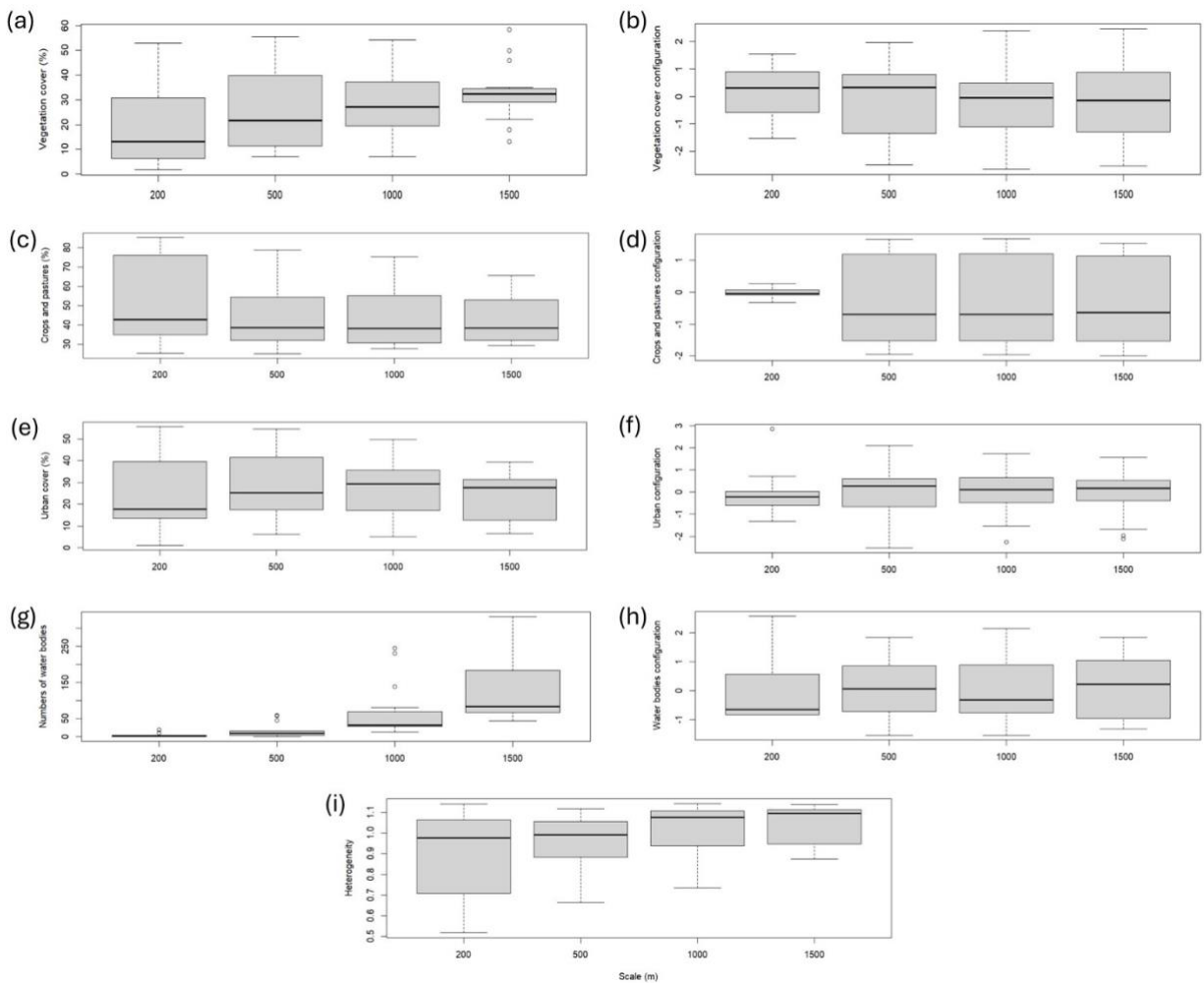


Fig. S1. Boxplots of variation of the landscape metrics: amount, configuration and heterogeneity at landscape level (sampling sites) for each buffer size (200, 500, 1000, and 1500 m).

Tables

Table S1. Regions (R1, R2), sampling localities (with geographic coordinates) and anuran species studied along the Sierra Madre del Sur, Oaxaca, Mexico. Terrestrial species *RH*: *Rhinella horribilis* and *LM*: *Leptodactylus melanonotus*. Arboreal species *SB*: *Smilisca baudinii* and *TS*: *Tlalocohyla smithii*. The number of individuals analyzed is listed per species.

	Locality	Latitude	Longitude	<i>RH</i>	<i>LM</i>	<i>SB</i>	<i>TS</i>	Total
R1	Santa María Zacatepec-A (ZAA)	16.768109,	-97.994140	10	8	8	-	
	Santa María Zacatepec-B (ZAB)	16.764728,	-97.983878	15	-	8	-	
	San Pedro Amuzgos-A (AMA)	16.653897,	-98.112965	23	6	3	-	
	San Pedro Amuzgos-B (AMB)	16.644937,	-98.084327	10	4	-	-	
	Santa María Ipalapa-A (IPA)	16.633628,	-98.035396	24	8	8	-	
	Santa María Ipalapa-B (IPB)	16.641006,	-98.008006	10	-	4	-	
	San Juan Cacahuatpec-A (CAA)	16.62193,	-98.15385	11	8	8	-	
	San Juan Cacahuatpec-B (CAA)	16.606057,	-98.15343	23	7	8	-	
Total				125	41	47		213
R2	Santa Ana Tututepec-A (SAA)	16.184008,	-97.536841	8	7	8	12	
	Santa Ana Tututepec-B (SAB)	16.186110,	-97.526724	4	4	8	-	
	Santa Cruz Tututepec-A (SCA)	16.186110,	-97.526724	-	7	8	6	
	Santa Cruz Tututepe-B (SCB)	16.2170,	-97.526	11	7	8	13	
	Santa Cruz Tepenixtlahuaca-A (TEA)	16.2835,	-97.499563	10	7	8	10	
	Santa Cruz Tepenixtlahuaca-B (TEB)	16.2880,	-97.487	20	7	8	11	
	Peñas Negras-DV (DV)	16.230478,	-97.50671	-	7	-	14	
	Peñas Negras-A (PNA)	16.218377,	-97.489717	3	5	-	9	
	Peñas Negras-B (PNB)	16.248515,	-97.47315	8	-	-	14	
Total				64	51	48	89	252
R1+R2				189	92	95	89	465

Table S2. Results of principal component analyses of the two-configuration metrics: patch density (PD) and patch aggregation (PA). The PC1 contributing variable per landscape metric and the variance explained are shown by land use class and scale of analysis.

Land use class	Landscape metric	PC1	Scale (m)			
			200	500	1000	1500
Vegetation cover (VC)	PD	Contributing variable	0.7	0.7	0.7	0.7
	PA	Contributing variable	-0.7	-0.7	-0.7	-0.7
		Variance explained	0.6	0.77	0.83	0.93
Urban zones (UZ)	PD	Contributing variable	0.7	0.7	0.7	0.7
	PA	Contributing variable	-0.7	-0.7	-0.7	-0.7
		Variance explained	0.62	0.63	0.6	0.59
Crops/pastures (CP)	PD	Contributing variable	0.7	0.7	0.7	0.7
	PA	Contributing variable	-0.7	-0.7	-0.7	-0.7
		Variance explained	0.98	0.99	0.96	0.99
Water bodies (WB)	PD	Contributing variable	0.7	0.7	0.7	0.7
	PA	Contributing variable	0.7	0.7	0.7	0.7
		Variance explained	0.75	0.6	0.62	0.68

Table S3. Full database including region, sampling site, genetic metrics by species, and the nine landscape metrics evaluated per scale (200, 500, 1000, 1500 m). Table is provided as an independent excel archive.

Table S4. Genetic diversity and differentiation by region (R1, R2), sampling locality and species. LOC: locality; *Ho*: observed heterozygosity; *F_{IS}*: inbreeding coefficient; *Pa*: private alleles; *F_{ST}*: fixation Index. Tot: total ± standard deviation in “()”. The abbreviations for the sampling localities are included in table S1.

LOC	<i>Rhinella horribilis</i>				<i>Leptodactylus melanonotus</i>				<i>Smilisca baudinii</i>				<i>Tlalocohyla smithii</i>			
R1	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>
ZAA	0.312	-0.151	1	0.016	0.210	0.017	39	0.049	0.229	0.015	5	0.006	--	--	--	--
ZAB	0.316	-0.160	3	0.016	-	-	-	-	0.224	0.021	6	0.010	--	--	--	--
AMA	0.306	-0.154	10	0.017	0.237	0.014	9	0.017	0.222	0.012	0	0.003	--	--	--	--
AMB	0.313	-0.162	0	0.018	0.231	0.024	19	0.025	-	-	-	-	--	--	--	--
IPA	0.290	-0.109	7	0.015	0.232	0.019	46	0.025	0.229	0.015	12	0.006	--	--	--	--
IPB	0.310	-0.151	0	0.011	-	-	-	-	0.242	-0.005	0	0.003	--	--	--	--
CAA	0.314	-0.160	0	0.013	0.235	0.018	29	0.021	0.227	0.021	10	0.004	--	--	--	--
CAB	0.308	-0.154	4	0.015	0.235	0.025	18	0.019	0.219	0.033	10	0.006	--	--	--	--
Tot	0.309 (0.008)	-0.150 (0.02)	3.12 (4)	0.015 (0.002)	0.230 (0.01)	0.019 (0.004)	26.66 (14)	0.026 (0.01)	0.228 (0.007)	0.016 (0.012)	6.14 (5)	0.006 (0.002)	--	--	--	--
R2	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>	<i>Ho</i>	<i>F_{IS}</i>	<i>Pa</i>	<i>F_{ST}</i>
SAA	0.360	-0.152	1	0.017	0.259	0.020	81	0.067	0.225	0.020	6	0.006	0.172	0.015	2	0.011
SAB	0.341	-0.117	0	0.021	0.256	0.013	8	0.075	0.218	0.022	6	0.007	0.176	-0.011	0	0.006
SCA	-	-	-	-	0.251	0.018	15	0.040	0.225	0.014	8	0.005	-	-	-	-
SCB	0.364	-0.158	2	0.010	0.245	0.024	17	0.041	0.224	0.016	8	0.004	0.174	-0.009	1	0.009
TEA	0.360	-0.16	0	0.019	0.239	0.018	5	0.046	0.222	0.020	9	0.008	0.172	0.007	0	0.008
TEB	0.350	-0.14	16	0.015	0.240	0.009	14	0.053	0.220	0.023	12	0.005	0.174	-0.001	0	0.006
DV	-	-	-	-	0.243	0.034	9	0.036	-	-	-	-	0.165	0.000	0	0.020
PNA	0.336	-0.112	0	0.012	-	-	-	-	-	-	-	-	0.173	0.009	2	0.012
PNB	0.347	-0.136	1	0.017	0.207	0.022	19	0.095	-	-	-	-	0.166	0.008	2	0.008
Tot	0.351 (0.01)	-0.139 (0.019)	2.85 (6)	0.016 (0.003)	0.242 (0.016)	0.020 (0.007)	21.00 (25)	0.057 (0.02)	0.222 (0.002)	0.019 (0.004)	8.16 (2)	0.006 (0.001)	0.171 (0.003)	0.002 (0.009)	0.8 (1)	0.010 (0.004)
R1+	0.328	-0.145	3.00	0.015	0.237	0.020	23.42	0.043	0.225	0.018	7.07	0.006	0.171	0.002	0.8	0.01
R2	(0.023)	(0.018)	(5)	(0.002)	(0.014)	(0.006)	(20)	(0.02)	(0.006)	(0.009)	(4)	(0.002)	(0.003)	(0.009)	(1))	(0.004)

Table S5. Best scale landscape metric amount and configuration of land class (vegetation cover, urban zones, water bodies and crops/pastures), and heterogeneity by species and genetic metric. The lowest AIC values are highlighted in **bold** and are considered the 'best scale'. Scale of analysis is shown in meters (m).

Species	Genetic metric	Landscape variable	Scale / AIC			
			200	500	1000	1500
<i>Rhinella horribilis</i>	Observed heterozygosity (H_o)	Vegetation cover amount	-61	-61.9	-63.4	-63
		Vegetation cover configuration	-67.6	-66.2	-66.2	-66.8
		Urban amount	-70.7	-66.1	-67.4	-70.3
		Urban configuration	-62	-61.2	-62	-63.2
		Crops/pastures amount	-70.3	-69.6	-69.6	-68.1
		Crops/pastures configuration	-64.1	-65.9	-64.8	-63.3
		Number of water bodies	-64.1	-60.6	-58	-57.5
		Water bodies configuration	-65.9	-66.6	-67.5	-67.7
	Inbreeding coefficient (F_{IS})	Heterogeneity	-70.6	-75.8	-74.5	-73.4
		Vegetation cover amount	-47.6	-47.3	-48.3	-48.8
		Vegetation cover configuration	-53.4	-52.4	-52.6	-52.5
		Urban amount	-54.2	-52.4	-53.9	-50.2
		Urban configuration	-47.5	-47.5	-48.7	-57.5
		Crops/pastures amount	-47.3	-48.6	-48.2	-48.1
		Crops/pastures configuration	-56.5	-52.9	-52.9	-53.3
		Number of water bodies	-51.7	-47.4	-44.3	-43.9
	Private alleles (P_a)	Water bodies configuration	-52.8	-52.9	-53.8	-53
		Heterogeneity	-56.2	-59.3	-58	-58.2
		Vegetation cover amount	82.4	79.3	77.1	75.3
		Vegetation cover configuration	82.5	79.9	79.6	81
		Urban amount	87.6	95.8	99.2	107.1
		Urban configuration	115.6	98.9	113.3	115.3
		Crops/pastures amount	116.8	117.2	119	118
		Crops/pastures configuration	113.9	119	119	115.8
		Number of water bodies	71.7	73.4	73.5	73.2
		Water bodies configuration	72.9	73	73.5	73

	Fixation index (F_{ST})	Heterogeneity	71.4	71.7	72	71.7
		Vegetation cover amount	-95.4	-94.9	-95.3	-95.7
		Vegetation cover configuration	-100.8	-100.2	-100.1	-100
		Urban amount	-95.1	-95.1	-95.7	-95.8
		Urban configuration	-105.4	-101.1	-103.3	-102.4
		Crops/pastures amount	-95.1	-95.2	-94.6	-95.6
		Crops/pastures configuration	-99.9	-108.4	-99.9	-99.9
		Number of water bodies	-97.6	-94.6	-92	-91.6
		Water bodies configuration	-100.8	-101.3	-100.5	-100.4
		Heterogeneity	-104.3	-105.2	-106	-105.5
<i>Leptodactylus melanonotus</i>	Observed heterozygosity (H_o)	Vegetation cover amount	-51.4	-49.2	-50.6	-50.7
		Vegetation cover configuration	-56.6	-53.2	-53.4	-53.5
		Urban amount	-48.5	-48.3	-49.9	-50
		Urban configuration	-53.5	-54.3	-56.9	-54
		Crops/pastures amount	-54	-52	-56	-56.4
		Crops/pastures configuration	-57.1	-54.6	-54.5	-54.3
		Number of water bodies	-54.7	-48.6	-48.2	-50.2
		Water bodies configuration	-53	-53.6	-54.7	-59.2
	Inbreeding coefficient (F_{IS})	Heterogeneity	-60.9	-57.5	-59	-58.9
		Vegetation cover amount	-74.3	-73.8	-74.5	-74.6
		Vegetation cover configuration	-68.8	-68.4	-70.8	-71.7
		Urban amount	-73.4	-73.8	-74	-72.6
		Urban configuration	-77.5	-76.2	-75.3	-74.4
		Crops/pastures amount	-67.8	-69.3	-68.4	-68.8
		Crops/pastures configuration	-85.1	-73.1	-73.1	-73.2
		Number of water bodies	-70.5	-68.4	-65.8	-65.4
	Private alleles (P_a)	Water bodies configuration	-73.4	-73.8	-73.9	-73.6
		Heterogeneity	-78.9	-86	-77.6	-86.4
		Vegetation cover amount	255.1	247.1	254.1	251.5
		Vegetation cover configuration	248.6	239.2	250.4	250.8
		Urban amount	255.1	241.5	249.1	255.1

	Fixation index (F_{ST})	Urban configuration	255.2	253	238.9	224.6
		Crops/pastures amount	253.8	254.6	253.8	248.6
		Crops/pastures configuration	252.1	248.2	248.3	234.9
		Number of water bodies	249.8	231.8	231.8	236
		Water bodies configuration	255.1	247.2	251.6	250.9
		Heterogeneity	254.5	254.9	246.7	244.3
		Vegetation cover amount	-42.2	-42	-42.9	-44.8
		Vegetation cover configuration	-47.6	-48.7	-49	-49.6
		Urban amount	-41.2	-41.5	-42.1	-42.7
		Urban configuration	-47.3	-49.8	-50	-47.2
		Crops/pastures amount	-43.8	-45.4	-46.8	-51.1
		Crops/pastures configuration	-49.1	-48.1	-48	-48.2
		Number of water bodies	-43.8	-39.6	-41.2	-41.3
		Water bodies configuration	-46.8	-47.2	-47.5	-50.1
		Heterogeneity	-50.7	-51.2	-53	-52.7
		Vegetation cover amount	-62.2	-63.5	-63.7	-64.3
		Vegetation cover configuration	-69	-71.2	-70.5	-70.3
		Urban amount	-62.1	-63.4	-62.9	-63.4
		Urban configuration	-67.5	-70.4	-76.4	-76.3
		Crops/pastures amount	-62.8	-63	-62.8	-63.3
<i>Smilisca baudinii</i>	Observed heterozygosity (H_o)	Crops/pastures configuration	-71.3	-67.9	-67.9	-68
		Number of water bodies	-64	-61.5	-58.8	-58.4
		Water bodies configuration	-67.6	-67.9	-68.6	-68.2
		Heterogeneity	-71.8	-71.8	-72.3	-73.2
		Vegetation cover amount	-59.2	-56.2	-61.5	-60.6
		Vegetation cover configuration	-54.1	-62.7	-54.6	-55.4
		Urban amount	-54.5	-54.9	-54.2	-54.7
		Urban configuration	-59.2	-61.7	-66	-65
	Inbreeding coefficient (F_{IS})	Crops/pastures amount	-53	-54	-54.1	-54.9
		Crops/pastures configuration	-62.7	-60.2	-59.9	-59.3
		Number of water bodies	-55.8	-53.1	-50.4	-50
		Water bodies configuration	-60	-59.9	-59.4	-59.1

<i>Tlalocohyla smithii</i>	Private alleles (P_a)	Heterogeneity	-62.1	-63.2	-63.3	-63.9
		Vegetation cover amount	83.9	85.6	86.5	85.1
		Vegetation cover configuration	84	84.2	86.6	85.8
		Urban amount	84.9	86.4	87.3	86.9
		Urban configuration	87.1	86.1	83.9	83.6
		Crops/pastures amount	87	86.2	87.2	86.9
		Crops/pastures configuration	83.6	86.7	83	82.9
		Number of water bodies	79	86.1	87.3	87.4
		Water bodies configuration	81.6	84.9	84.2	85.6
		Heterogeneity	87.4	87.3	86.6	86.7
	Fixation index (F_{ST})	Vegetation cover amount	-92.7	-92.2	-92.4	-92.1
		Vegetation cover configuration	-86.9	-87.5	-88.1	-88.8
		Urban amount	-86.7	-87.3	-88.2	-88.4
		Urban configuration	-93.3	-93.1	-93.4	-93.2
		Crops/pastures amount	-86.2	-87	-87.6	-87.9
		Crops/pastures configuration	-96.1	-92.7	-92.6	-92.1
		Number of water bodies	-89.2	-91.2	-87.4	-89.1
		Water bodies configuration	-92	-93.6	-94.6	-92.9
		Heterogeneity	-95.4	-96.8	-96.6	-97.3
	Observed heterozygosity (H_o)	Vegetation cover configuration	-61.8	-61.3	-62.6	-61.7
		Urban amount	-61.6	-62.7	-63.5	-63
		Urban configuration	-61.3	-62.9	-64.2	-66.8
		Crops/pastures amount	-62.4	-61.5	-61.8	-61.5
		Crops/pastures configuration	-61.1	-62.8	-62.1	-63.5
		Number of water bodies	-63.2	-62.3	-61.9	-63.5
		Water bodies configuration	-62.4	-64.5	-61.6	-65.7
		Heterogeneity	-62.4	-62.3	-61.5	-62.3
		Vegetation cover amount	-48.6	-47.4	-47.7	-48.2
	Inbreeding coefficient (F_{IS})	Vegetation cover configuration	-49.3	-47.4	-48	-47.9
		Urban amount	-47.6	-47.4	-47.4	-47.5

Private alleles (P_a)	Urban configuration	-47.6	-48.2	-48.1	-47.5
	Crops/pastures amount	-47.4	-47.4	-48.1	-48.6
	Crops/pastures configuration	-47.4	-48.5	-47.9	-48.1
	Number of water bodies	-50.8	-48.4	-51.1	-47.4
	Water bodies configuration	-49.5	-47.4	-48	-47.4
	Heterogeneity	-47.5	-47.7	-48	-47.4
	Vegetation cover amount	23.1	24	23.5	22.2
	Vegetation cover configuration	23.5	24	23	21.3
	Urban amount	18.5	22.3	22.2	20.6
	Urban configuration	22.1	23.4	23.7	24
Fixation index (F_{ST})	Crops/pastures amount	24	23.5	24	23.6
	Crops/pastures configuration	20.7	24	23.9	24
	Number of water bodies	23.5	23.1	22.8	21.8
	Water bodies configuration	23.5	24	23.1	23.9
	Heterogeneity	22.9	21.2	24	22
	Vegetation cover amount	-58.3	-60.9	-64.3	-62.7
	Vegetation cover configuration	-60	-63	-63.5	-60.6
	Urban amount	-58.5	-61.6	-67.3	-60.9
	Urban configuration	-57.9	-59.9	-61.2	-61.7
	Crops/pastures amount	-58	-58.3	-60.4	-60.8
	Crops/pastures configuration	-58	-61.4	-60.4	-62.8
	Number of water bodies	-58.9	-59.1	-58.2	-67.2
	Water bodies configuration	-58.7	-58	-60.5	-74.5
	Heterogeneity	-57.9	-57.9	-58.2	-58.6
