Supplementary Material "Amphibian metacommunity responses to agricultural intensification in a Mediterranean landscape"

Luis Albero[a,1], Íñigo Martínez-Solano[b], Ana Arias[c], Miguel Lizana[c], Eloy Bécares[a].

[a] Área de Ecología, Departamento de Biodiversidad y Gestión Ambiental, Facultad de

Ciencias Biológicas, Universidad de León (ULE). Callejón Campus Vegazana s/n,

24071 León, Spain. [1]: lalbm@unileon.es

[b] Museo Nacional de Ciencias Naturales (MNCN-CSIC), c/ José Gutiérrez Abascal, 2, 28006 Madrid, Spain.

[c] Departamento de Biologia Animal (Zoologia), Facultad de Biología, Facultad de Ciencias Agrarias y Ambientales. Universidad de Salamanca 37007 Salamanca, Spain

Table S1: Location of the sampled 32 ponds and agricultural management groups (Datum: WGS84).

Pond name	Zone	Coord. X	Coord. Y	Agriculture
COSTRAMILLAS	30T	311920	4703041	Irrigated
CABRAS I	30T	316867	4701123	Irrigated
CABRAS III	30T	317207	4701357	Irrigated
CAL	30T	306355	4699511	Irrigated
CARRILLÓN	30T	308242	4702330	Irrigated
CASTELLANA	30T	306701	4700902	Irrigated
CIMERA	30T	309848	4706650	Irrigated
DIEL	30T	313612	4710654	Irrigated
ENTREVALLES	30T	313879	4703374	Irrigated
ESPINO	30T	316442	4704360	Irrigated
ESTORRUBIO	30T	318432	4703794	Irrigated
IBAÑEZ	30T	307434	4697693	Irrigated
MAYOR	30T	316571	4706972	Irrigated
REDOS	30T	317456	4704938	Irrigated
TILLO	30T	315608	4702306	Irrigated
VILLIDÁN	30T	309844	4701302	Irrigated
CAMPOLAGUNAS	30T	324203	4114970	Rainfed
CANTOS	30T	315526	4711367	Rainfed
COTICO I	30T	319609	4710950	Rainfed
COTICO II	30T	319380	4710698	Rainfed
DEL MONTE I	30T	322621	4710753	Rainfed
ERA	30T	320419	4716020	Rainfed
GENTE	30T	317335	4714895	Rainfed
LAGUNETAS SENTIZ	30T	319012	4714347	Rainfed
POZO AGUJA	30T	320965	4715612	Rainfed
QUINTANA	30T	324633	4715945	Rainfed
REGUERO DE LA RAYA	30T	328000	4714338	Rainfed
RUEDA	30T	318399	4711455	Rainfed
SENTIZ	30T	318796	4713892	Rainfed
TIERRAS DE VALDEARCOS	30T	316172	4710420	Rainfed
TRIGO/RAQUETA	30T	319787	4712531	Rainfed
VELAZA	30T	319047	4706521	Rainfed

Table S2: Pearson's correlation between environmental variables from sampled ponds. In brown, removed variables due to high correlation. Local variables are AREA: pond area (m^2), MXDE: maximum pond depth on all visits (cm), MEDE: medium pond depth on all visits (cm), HECO: proportion of helophyte cover over pond area (0-1). Landscape variables (proportion of surface on a 500m or 1000m buffer around the pond) are ARTR: man-made forest, poplar or pine, GRA: grasslands, WET: wetlands other than the sampled pond, NTTR: natural oak forest, ART: artificial surfaces, BAR: bare ground, SCR: scrublands.

	AREA	MXDE	MEDE	HECO	ARTR1000	NTTR1000	ART1000	BAR1000	GRA1000	WET1000	SCR1000	IRR1000	NIR1000
AREA	1	0,372983	0,383416	0,185965	-0,07667	-0,08468	-0,00151	-0,091890459	-0,01934	0,08248672	-0,04609243	0,02636905	0,062320603
MXDE	0,372983	1	0,973314	0,393733	0,15148	-0,01602	0,22637	0,090782333	0,058836	-0,02910589	0,26336654	0,08518281	-0,229295207
MEDE	0,383416	0,973314	1	0,363234	0,152251	-0,01358	0,244544	0,131738244	0,109705	-0,03147541	0,26263803	0,06655423	-0,266309797
HECO	0,185965	0,393733	0,363234	1	0,066597	0,071001	0,206607	-0,101100483	-0,06592	-0,11619421	0,14095138	-0,00527114	-0,077458019
ARTR1000	-0,07667	0,15148	0,152251	0,066597	1	0,051506	-0,04652	0,418464774	0,033418	-0,01347783	0,20854553	-0,20054936	-0,007244315
NTTR1000	-0,08468	-0,01602	-0,01358	0,071001	0,051506	1	-0,13424	0,458213583	-0,17346	-0,16847975	0,08266622	-0,26449559	-0,400297225
ART1000	-0,00151	0,22637	0,244544	0,206607	-0,04652	-0,13424	1	0,094845833	-0,27029	0,02273015	0,09749607	0,29202179	-0,347530684
BAR1000	-0,09189	0,090782	0,131738	-0,1011	0,418465	0,458214	0,094846	1	0,103251	-0,06027361	0,2880474	-0,28397909	-0,344187653
GRA1000	-0,01934	0,058836	0,109705	-0,06592	0,033418	-0,17346	-0,27029	0,103251005	1	-0,06961191	0,23897905	-0,4274637	-0,209265487
WET1000	0,082487	-0,02911	-0,03148	-0,11619	-0,01348	-0,16848	0,02273	-0,060273613	-0,06961	1	0,02590054	0,06078158	-0,049938072
SCR1000	-0,04609	0,263367	0,262638	0,140951	0,208546	0,082666	0,097496	0,2880474	0,238979	0,02590054	1	-0,14364468	-0,266483104
IRR1000	0,026369	0,085183	0,066554	-0,00527	-0,20055	-0,2645	0,292022	-0,283979087	-0,42746	0,06078158	-0,14364468	1	-0,370028165
NIR1000	0,062321	-0,2293	-0,26631	-0,07746	-0,00724	-0,4003	-0,34753	-0,344187653	-0,20927	-0,04993807	-0,2664831	-0,37002816	1
ARTR500	-0,08002	0,003048	0,050617	-0,02255	0,638183	0,130775	0,114912	0,659686521	0,16193	0,01889173	0,36117488	-0,15692628	-0,267009663
NTTR500	-0,10989	-0,06712	-0,06222	-0,00082	0,005948	0,921155	-0,13925	0,373196096	-0,07481	-0,15334274	0,10409169	-0,31703031	-0,366099463
ART500	-0,06076	0,129525	0,158448	0,176585	0,018657	-0,03133	0,907448	0,212262849	-0,18159	0,02543235	0,07764428	0,07212716	-0,291577013
BAR500	-0,03055	0,062258	0,109692	-0,00806	0,521125	0,314745	0,088505	0,885044039	0,098868	-0,15817159	0,27317107	-0,24623479	-0,238475515
GRA500	0,131452	0,265632	0,327017	0,117281	-0,10005	-0,04559	-0,33165	-0,065668685	0,71822	-0,17722908	0,21639174	-0,36011957	-0,072708511
WET500	0,285818	0,063474	0,08304	0,123801	0,009393	-0,11369	-0,04652	-0,254291944	0,045079	0,64004213	-0,04680859	0,05333767	-0,079841411
SCR500	-0,0539	0,331604	0,294719	0,151511	0,174197	0,066982	0,048905	0,278934211	0,244728	-0,07005118	0,81815654	-0,11541763	-0,231061025
IRR500	-0,03303	-0,01141	-0,04862	-0,03696	-0,21781	-0,16968	0,251065	-0,204676977	-0,40569	0,03135016	-0,0783377	0,88605247	-0,351180356
NIR500	-0,03131	-0,26503	-0,30921	-0,17341	0,178028	-0,37239	-0,26582	-0,152750539	-0,16535	0,09831985	-0,28786703	-0,30804748	0,800492538

Table S2 (2):

	ARTR500	NTTR500	ART500	BAR500	GRA500	WET500	SCR500	IRR500	NIR500
AREA	-0,08001727	-0,10988711	-0,06076	-0,03055	0,131452	0,285818	-0,0539	-0,033029651	-0,03131
MXDE	0,003048293	-0,06712035	0,129525	0,062258	0,265632	0,063474	0,331604	-0,011409726	-0,26503
MEDE	0,050616793	-0,06221951	0,158448	0,109692	0,327017	0,08304	0,294719	-0,048621089	-0,30921
HECO	-0,02254761	-0,00082159	0,176585	-0,00806	0,117281	0,123801	0,151511	-0,036964268	-0,17341
ARTR1000	0,638183021	0,005947945	0,018657	0,521125	-0,10005	0,009393	0,174197	-0,21780988	0,178028
NTTR1000	0,130774858	0,921154786	-0,03133	0,314745	-0,04559	-0,11369	0,066982	-0,16968311	-0,37239
ART1000	0,114911677	-0,13924519	0,907448	0,088505	-0,33165	-0,04652	0,048905	0,251064635	-0,26582
BAR1000	0,659686521	0,373196096	0,212263	0,885044	-0,06567	-0,25429	0,278934	-0,204676977	-0,15275
GRA1000	0,161930098	-0,07481227	-0,18159	0,098868	0,71822	0,045079	0,244728	-0,40568822	-0,16535
WET1000	0,018891731	-0,15334274	0,025432	-0,15817	-0,17723	0,640042	-0,07005	0,031350158	0,09832
SCR1000	0,361174878	0,104091692	0,077644	0,273171	0,216392	-0,04681	0,818157	-0,078337697	-0,28787
IRR1000	-0,15692628	-0,31703031	0,072127	-0,24623	-0,36012	0,053338	-0,11542	0,886052471	-0,30805
NIR1000	-0,26700966	-0,36609946	-0,29158	-0,23848	-0,07271	-0,07984	-0,23106	-0,351180356	0,800493
ARTR500	1	0,098298266	0,150319	0,790665	-0,08187	0,026605	0,231674	-0,189181292	-0,03256
NTTR500	0,098298266	1	-0,04356	0,21579	-0,02684	-0,12271	0,115185	-0,270420788	-0,33229
ART500	0,150318532	-0,04355714	1	0,181705	-0,30738	-0,08087	0,029129	0,068790908	-0,22204
BAR500	0,790664868	0,215789828	0,181705	1	-0,09511	-0,21069	0,174311	-0,176772039	-0,0638
GRA500	-0,08187128	-0,02684185	-0,30738	-0,09511	1	0,033643	0,239451	-0,406984071	-0,34758
WET500	0,026604648	-0,12270687	-0,08087	-0,21069	0,033643	1	-0,04188	0,00712565	-0,10094
SCR500	0,231673747	0,115185255	0,029129	0,174311	0,239451	-0,04188	1	-0,074937194	-0,28792
IRR500	-0,18918129	-0,27042079	0,068791	-0,17677	-0,40698	0,007126	-0,07494	1	-0,39219
NIR500	-0,03256228	-0,33229299	-0,22204	-0,0638	-0,34758	-0,10094	-0,28792	-0,39219131	1

Table S3: Means and range of values for environmental variables recorded in ponds in the two agricultural management areas, with statistical significance of differences between irrigated and rainfed groups assessed with Mann-Whitney tests. Variable names as in table S2.

	AREA	MEDE	HECO	ARTR1000	GRA1000	WET1000	NTTR500	ART500	BAR500	SCR500	IRR500	NIR500
Rainfed	8763,1 (42201-1360)	79,27 (140-35)	28,06 (68,6-0)	1,28 (7,48-0)	25,42 (45,7-7,56)	1,76 (9,93-0)	11,47 (50,11-0,29)	7,50 (23,35-2,08)	0,71 (4,28-0)	0,61 (3,6-0)	3,19 (8,11-0)	45,34 (78,18-2,19)
Irrigated	8339,31 (19441-1139)	68,36 (130-35)	32,50 (82,27-0)	0,18 (0,66-0)	18,33 (31,08-6,42)	1,84 (10,52-0,30)	0,65 (5,25-0)	11,41 (19,47-6,23)	0,03 (0,25-0)	0,08 (6,31-0)	20,61 (64,5-0)	46,38 (72,29-13,71)
Difference	423,81	10,91	-4,43	1,10	7,10	-0,09	10,81	-3,91	0,68	0,53	-17,43	-1,04
% difference	4,84	13,77	-15,80	86,11	27,92	-4,97	94,29	-52,07	96,38	87,56	-547,10	-2,29
Mann-Withney U	138	103	137	73	80	159	21	201	46	62	213,5	133
p-value	0,72	0,35	0,75	0,039*	0,073	0,25	0,000056*	0,0051*	0,00086*	0,0099*	0,0014*	0,87

Local scale: pond area in m^2 (AREA); medium pond depth in cm (MEDE); helophyte cover in % pond area (HECO). In % cover at a 1000-m scale from the pond: man-made forest, poplar or pine (ARTR); grasslands (GRA1000); wetlands (WET1000). In % cover at a 500-m scale from the pond: natural oak forest (NTTR500), artificial surfaces (ART500), bare ground (BAR500), scrub (SCR500), irrigated crops (IRR500), and rainfed crops (NIR500). *: Significant under α=0,05. NA: Non-applicable

Table S4: Environmental variables summarized via Principal Components Analysis (PCA) showing the scores for each principal component (PC) and environmental variable.

	PC1	PC2	PC3	PC4	PC5	PC6
EIGEN	2,745	1,855	1,709	1,402	1,24	1,048
CUM PR	0,211	0,353	0,485	0,593	0,688	0,769
AREA	0,27	**-0,63**	**0,64**	-0,05	0,18	0,07
MEDE	**0,91**	-0,58	0,27	0,09	-0,09	0,10
HECO	0,50	-0,47	0,15	0,01	**0,58**	0,31
ARTR1000	0,49	0,37	-0,04	**0,74**	-0,15	0,54
GRA1000	**0,89**	0,12	0,44	-0,22	-0,15	-0,53
WET1000	-0,32	-0,03	0,28	0,36	**-0,59**	**-0,63**
NTTR500	0,21	0,57	-0,57	-0,47	0,52	-0,20
ART500	-0,07	-0,55	-0,58	**0,72**	0,20	-0,42
BAR500	0,58	0,26	-0,51	**0,62**	0,19	-0,10
SCR500	**0,92**	0,09	-0,13	0,00	-0,22	-0,21
IRR500	-0,39	**-0,80**	**-0,60**	-0,15	-0,49	0,29
NIR500	-0,55	0,52	**0,72**	0,50	0,12	0,18

EIGEN: Eigenvalues for each of the Principal Components; CUM PR: Cumulative proportion explained of the environmental variation by the PCs.

Interpretation of the PCs:

PC1: High values indicate deep ponds in heterogeneous landscapes with high cover of natural vegetation and low cover of crops.

PC2: High values correspond to large ponds in landscapes with low cover of irrigated crops.

PC3: This PC is similar to PC2 but corresponds to landscapes dominated by rainfed crops and grasslands.

PC4: High values correspond to ponds in semi-humanized landscapes with tree plantations, urban areas, rainfed crops and bare soil.

PC5: High values correspond to shaded ponds (high helophyte cover) in landscapes with low wetland cover.

PC6: High values correspond to isolated ponds (low wetland cover).

Table S5: Occurrences of amphibian species (number and proportion of occupied ponds) in irrigated vs. rainfed ponds. Statistical significance of differences was assessed by means of Fisher's test.

	P. waltl	***T. marmoratus***	***P. cultripes***	***D. galganoi***	***B. spinosus***	***E. calamita***	***H. molleri***	***P. perezi***
Irrigated	10 (0.62)	14 (0.87)	8 (0.5)	0 (0)	1 (0.62)	6 (0.37)	13 (0.81)	11 (0.68)
Rainfed	14 (0.87)	14 (0.87)	15 (0.93)	5 (0.31)	4 (0.25)	6 (0.37)	16 (1)	15 (0.93)
All ponds	24 (0.75)	28 (0.87)	23 (0.72)	5 (0.16)	5 (0.16)	12 (0.37)	29 (0.9)	26 (0.81)
Fisher p	0,22	NA	0,015*	0,043*	0,33	NA	0,23	0,17

**:* Significant under α=0,05. NA: non-applicable.

Table S6: Results of the SIMPER analysis between irrigated and rainfed pond communities.

	Average	sd	Ratio	Av.Ab. Irrigated	Av.Ab. Rainfed	Cum. Contr.	p
Pelobates cultripes	0.0593	0.0620	0.956	0.5000	0.938	0.191	0.0139 *
Epidalea calamita	0.0497	0.0551	0.902	0.3750	0.375	0.351	0.9930
Pleurodeles waltl	0.0469	0.0584	0.804	0.6250	0.875	0.502	0.3372
Pelophylax perezi	0.0433	0.0622	0.695	0.6875	0.938	0.641	0.1700
Discoglossus galganoi	0.0304	0.0461	0.660	0.0000	0.312	0.739	0.0010 ***
Bufo spinosus	0.0278	0.0453	0.614	0.0625	0.250	0.829	0.0655 ¨
Triturus marmoratus	0.0266	0.0521	0.511	0.8750	0.875	0.915	0.9967
Hyla molleri	0.0265	0.0561	0.473	0.8125	1.000	1.000	0.7092

Sd: Standard deviation. Av.Ab.: Average Abundance. Cum.Contr.: Cumulative contribution. Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '¨' 0.1 ' ' 1

Table S7: Abundances of amphibian species (individuals/1000 m^2) in irrigated vs. rainfed ponds. Statistical significance of differences between the two agricultural areas was assessed with ANOSIM test.

	P. waltl	***T. marmoratus***	***P. cultripes***	***D. galganoi***	***B. spinosus***	***E. calamita***	***H. molleri***
Mean irrigated	0,82	1,22	0,46	0,00	0,01	0,63	3,32
Mean rainfed	1,35	1,13	1,15	0,10	0,12	0,63	2,97
Mean overall	1,08	1,18	0,81	0,05	0,06	0,63	3,15
ANOSIM R	-0,01	-0,008	0,04	NA	0,009	-0,006	0,016
p-value	0,54	0,45	0,11	NA	0,15	0,45	0,22

*: Significant under α=0,05. NA: Non-applicable

Table S8: Results of the logistic regression analysis for amphibian species presence using all ponds and summarizing environmental variables via PCA. Estimates are shown along with significance.

	INTERCEPT	PC1	PC2	PC3	PC4	PC5	PC6
P. waltl	3,19*	2,56	2,39¨	-1,65	2,99	-	4,6¨
T. marmoratus	2,93**	1,98	-	-	1,89	-	-
D. galganoi	-3,85*	2,52*	-	1,98	-	-	-
P. cultripes	3,15*	3,9¨	2,46*	-	-2,46¨	-2,46¨	-2,11¨
E. calamita	-0,76	-1,27¨	0,89	-	-	-1,07¨	-
B. spinosus	-2,96*	!	-	1,65¨	-	-2,26	1,77¨
H. molleri	6,94	!	!	-1,75	-	-3,75	5,68
P. perezi	5,50*	2,15	-	-3,12	-	-3,55¨	5,13¨

!: This PC was removed as a variable from the logistic models due to problems of perfect separation (p-values=0 or 1).
Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '¨' 0.1 ' ' 1

Interpretation of the PCs (see table S4):
PC1: High values indicate deep ponds in heterogeneous landscapes with high cover of natural vegetation and low cover of crops.
PC2: High values correspond to large ponds in landscapes with low cover of irrigated crops.
PC3: This PC is similar to PC2 but corresponds to landscapes dominated by rainfed crops and grasslands.
PC4: High values correspond to ponds in semi-humanized landscapes with tree plantations, urban areas, rainfed crops and bare soil.
PC5: High values correspond to shaded ponds (high helophyte cover) in landscapes with low wetland cover.
PC6: High values correspond to isolated ponds (low wetland cover).