

Appendix A

Supplemental information

Table A1 National entities within the limits of the Alpine Convention: surface area, databases used, and number of data provided on the metamorphic alpine newts and used for the distribution analyses

Country	Surface area in the Alps	Data base	Provided resolution	Number of observation data
Austria	54,496 km ²	Austrian Herpetofauna Database, Natural History Museum Vienna	Point data	2213
France	40,724 km ²	Ligue pour la Protection des Oiseaux (GHRA / faune-paca.org)	Point data	5121
Germany	11,076 km ²	Artenschutzkartierung LfU	Point data	1664
Italy	52,274 km ²	Societas Herpetologica Italiana	1 km grid cell	1300
Liechtenstein	165 km ²	Office of Environment	Point data	561
Slovenia	6,804 km ²	Center za kartografijo favne in flore	Point data	194
Switzerland	25,188 km ²	info fauna karch	300 m grid cell	4560

Acronyms: GHRA: Groupe herpétologique Rhône-Alpes, faune-paca.org: Région Provence-Alpes-Côte-d'Azur) ; LfU: Bavarian Environment Agency; info fauna karch: Centre de Coordination pour la Protection des Amphibiens et Reptiles de Suisse; Point data: exact geographic coordinates of the observations.

Table A2 Paedomorphic populations of Alpine newts in the Alps: summarized data

Country	Mountain range	EEA 10km	Sites	Sites : Fish	Pers. visits	Pers. comm.	Literature
France	Savoy Pre-Alps	E399N251	1	0	0	CM	
France	Dauphine Alps	E400N244	1	0	1 (MD)	RD	
France	Dauphine Alps	E400N240	1	0	0	RD, MC	Denoël et al. 2001
France	Dauphine Alps	E401N240	3	2	3 (MD)	MC	Denoël et al. 2001; Breuil 1986
France	Dauphine Alps	E401N239	5	2	5 (MD)	GD, MC	Denoël et al 2001; Breuil 1986; Deso and Roinard 2015
France	Provence Alps	E403N237	1	0	1 (MD)	MB, AM	Breuil 1986; Denoël et al 2001
Germany	Bavarian Alps s.l.	E441N272	1	0	1 (MD)	JF	
Germany	Bavarian Alps s.l.	E449N275	1	1	1 (MD)	KH	Henle 1983
Italy	Graian Alps	E412N244	1	0	0	SB	
Italy	Ligurian alps	E414N233	1	0	1 (MD)	SB	Morand and Bovero, 2013
Italy	Ligurian Alps s.l.	E416N237	1	1	1 (MD)	FA	Andreone and Dore 1990
Italy	Ligurian Alps s.l.	E417N236	1	0	0	FA	Andreone and Dore 1990
Italy	Lepontine Alps	E419N258	1	1	1 (MD)	KG	de Filippi 1861; Denoël et al. 2001
Italy	East. Rhaetian Alps	E441N260	1	0	0	EH	Heiss 2017
Italy	Carnic Alps	E455N257	1	0	1 (MD)	FS	Dolce and Stoch 1984; Denoël et al. 2001
Slovenia	Julian Alps	E461N258	1	1	1 (MD, KP)		Seliskar and Pehani 1935
Switzerland	Lepontine Alps	E422N257	3	2	3 (MD)	PS, NZ	Ernst, 1952; Denoël et al. 2016

Abbreviations: EEA, European Environment Agency; s.l.: sensu lato; Sites, number of sites with paedomorphs per grid cell (10 x 10 km); Sites: Fish (number of sites with reported fish occurrence in each grid cell); Pers. visits, personal visits (number of sites visited for this study in each grid cell; observers: MD, M. Denoël, KP: Katja Pobolšaj), Pers. comm. (personal communication): CM, C. Miaud, RD, R. Duguet, MC, M. Corail, G.D., G. Deso, MB, M. Breuil, AM, A. Morand, JF, J. Fünfstück, KH, K. Henle, SB, Stefano Bovero, FA, F. Andreone, KG, Kurt Grossenbacher, EH, E. Heiss, FS, F. Stoch, PS, P. Scime, NZ, N. Zambelli.

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Table A3 Distribution data of the rare paedomorphic (P) and the common metamorphic (M) phenotypes of Alpine newts in the Alps and indexes of rarity at multiple spatial scales (i.e., resolutions).

Grid cell size	Spatial scale	Number of cells	Number of occupied cells (%)		Area of Occupancy (km ²)		Ratio P/M (%)	Relative index of rarity
			P	M	P	M		
1 x 1 km	1 km ²	194,009	25 (0.01%)	7,287 (3.75%)	25	7,287	0.34%	291.5
2 x 2 km	4 km ²	49,203	23 (0.05%)	5,417 (11.1%)	92	21,668	0.43%	235.5
5 x 5 km	25 km ²	8,156	20 (0.26%)	2,680 (32.9%)	500	67,000	0.75%	134.0
10 x 10 km	100 km ²	2,151	17 (0.84%)	1,197 (55.7%)	1,700	119,700	1.42%	70.4
20 x 20 km	400 km ²	589	15 (2.72%)	408 (69.3%)	6,000	163,200	3.68%	27.2
50 x 50 km	2,500 km ²	116	13 (12.07%)	91 (78.5%)	32,500	227,500	14.29%	7.0

Table A4 Number of 1 km² grid cell used at each coarser spatial scale of the rare paedomorphic and common metamorphic phenotypes of Alpine newts in their area of occupancy in the Alps.

Grid cell size	Spatial scale	Mean number of occupied 1 km ² cells per cell (SE)	
		Paedomorphs	Metamorphs
2 x 2 km	4 km ²	1.087 (0.006)	1.345 (0.009)
5 x 5 km	25 km ²	1.250 (0.123)	2.649 (0.045)
10 x 10 km	100 km ²	1.471 (0.027)	5.559 (0.187)
20 x 20 km	400 km ²	1.667 (0.033)	15.632 (0.931)
50 x 50 km	2,500 km ²	1.923 (0.473)	64.154 (9.307)

Table A5 Relation between the area of occupancy (AOO) and the extent of occurrence (EOO) at multiple spatial scales (i.e. resolutions) for the rare paedomorphic and common metamorphic phenotypes of Alpine newts in the Alps.

Grid cell size	Spatial scale	Extent of Occurrence divided by Area of occupancy	
		Paedomorphs	Metamorphs
1 x 1 km	1 km ²	5125.68	32.65
2 x 2 km	4 km ²	1392.85	10.98
5 x 5 km	25 km ²	256.28	2.74
10 x 10 km	100 km ²	75.38	1.99
20 x 20 km	400 km ²	21.36	1.46
50 x 50 km	2,500 km ²	3.94	1.05

See Table A3 for values of AOO at each spatial scale. The EOO is 128,142 km² and 239,949 km² for paedomorphs and metamorphs, respectively.

Table A6 IUCN Red List criteria at transalpine, national and regional scale in the Alps for the Alpine newt

Geographic scale	Country	Red List status	Reference
Transalpine – Species/metamorphs	All (Alps)	LC	This study; IUCN
Transalpine - Paedomorphs	All (Alps)	CE*	This study; IUCN SSC Amphibian Specialist Group 2022
National (Regional – Alps)	Austria	NT	Gollmann 2007
	France	LC (Regional: NT)	Marchand et al. 2017 ; UICN et al. 2015
	Germany	LC	Schulte and Thiesmeier 2020
	Italy	LC	Rondinini et al. 2013
	Liechtenstein	LC	Kühnis 2011
	Slovenia	LC (Ext for the paedomorphs)	Stankovic et al. 2015
	Switzerland	LC	Schmidt and Zumbach 2005

IUCN: Internal Union for nature Conservation; Regional: Provence Alpes Côte d'Azur. Abbreviation Red-list statutes: CE, Critically Endangered (* Based on an area of occupancy of less than 100 km² at the recommended 2 x 2 km spatial scale and on the presence of reported continued threat and declines), LC, Least Concern, NT, Near Threatened. Regional status is mentioned only when it differed from the national status.

Ext: Extinct paedomorphs in Slovenia refer to the subspecies *I. a. lacustris*

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Fig A1 Cluster of populations of paedomorphic alpine newts according to the Nearest Neighbour Index based on Delaunay's triangulation processed with data from the Alps (limits are those of the Alpine Convention). All points denote populations of paedomorphs (open circles: populations within the cluster; full circles: populations outside the cluster)

