Appendix 1 – Data description and complementation

1.1. Opportunistic presence data (calibration and cross-validation dataset)

Database name	Type	General website	Data proportion
Faune_anjou	Citizen bases with validation process by professionals	https://www.faune-anjou.org/	25%
Faune_maine		https://www.faune-maine.org/	10%
Faune_vendee		https://www.faune-vendee.org/	10%
Faune_loire_atlantique		https://www.faune-loire-atlantique.org/	11%
Biolovision		https://data.biolovision.net/	18%
URCPIE	Professional & volunteers	http://urcpie-paysdelaloire.org/	12%
Bretagne Vivante	Naturalist group	https://www.bretagne-vivante.org/	2%
ONF_BDN	Professional	https://www.onf.fr/	3%
SICEN	Professional	http://www.cenpaysdelaloire.fr/	3%
BASEPARC PNRMP / OPN	Professional	https://pnr.parc-marais-poitevin.fr/	2%
Naturalistes en lutte	Naturalist group	https://naturalistesenlutte.wordpress.com/	2%
Sterne 2.0	Professional	http://www.sterne2.com/	1%
Les naturalistes vendeens	Naturalist group	http://naturalistes-vendeens.org/	1%
Gouret_FLA	Naturalist individual base	-	<1%
Cap Atlantique	Professional	https://www.cap-atlantique.fr/accueil	<1%
Undragon.org	Citizen base	http://undragon.org/	<1%
ONCFS	Professional	http://www.oncfs.gouv.fr/	<1%

Table 1. Data sources

General coordination of the regional Atlas of amphibians: Ligue pour la Protection des Oiseaux – Pays-de-la-Loire (http://paysdelaloire.lpo.fr/).

	Opportunistic presence-only dataset (model calibration and cross-validation)	
Species	Total nb of presence	Nb of 500m presence-cells
Anourans:		
Bufo spinosus	8320	4127
Hyla arborea arborea	6344	3353
Pelodytes punctatus	2711	1103
Rana dalmatina	9073	3752
Rana temporaria	1525	477
Urodeles:		
Salamandra Salamandra terrestris	4916	2242
Triturus marmoratus	1478	629
Triturus cristatus	1791	766
Lissotriton helveticus	7047	2835

Table 2. Description of the presence-only data used for each of nine species for calibration and cross-validation of habitat suitability models. In the first part of the analyses, the model was calibrated with 70% of presence-only data and 30% of the data left were used for cross-validation.

1.2. Standardised detection-nondetection data (external validation dataset)

Name of the citizen science program: "Un Dragon dans mon Jardin"

Coordination: URCPIE – "Union régionale des centres d'initiatives pour l'environnement ».

For external SDM validation, we extracted detection-nondetection amphibian data from a regional citizen science database. This database contained 576 monitored aquatic sites for the period 2013-2019, with observations made in the context of a programme aiming to estimate amphibian population trends (regionally called "Un Dragon dans mon Jardin"). Observers followed a standard protocol; each site was monitored three times separated by at least one month - one diurnal between January and March and two nocturnal between March and June – to cover different species' breeding periods, during good weather conditions (no frost, no rain, no or weak wind). For each survey, three complementary methods were used to detect amphibians: an acoustic survey (5 min at 5 metres from the site without light) to detect breeding calls of male Anurans specie; an active visual survey using a flashlight torch (500-1000 lumens) to observe individuals and eggs and a catching survey using a net (3 net sweeps per site). These methods are commonly used for amphibian community surveys.

	CS.0		**VOL**		**PRO**	
Species	Nb of DET	Nb of NoDET	Nb of DET	Nb of NoDET	Nb of DET	Nb of NoDET
Anourans:						
Bufo spinosus	79	195	31	93	25	87
Hyla arborea arborea	98	176	43	81	62	50
Pelodytes punctatus	19	255	7	117	20	92
Rana dalmatina	176	98	64	60	71	41
Rana temporaria	14	260	5	119	2	110
Urodeles:						
Salamandra Salamandra terrestris	80	194	25	99	23	89
Triturus marmoratus	43	231	20	104	14	98
Triturus cristatus	30	244	16	108	24	88
Lissotriton helveticus	171	103	59	65	65	47

Table 3. Description of the initial datasets without filtering for each of nine species used for external validation of habitat suitability models. CS.0: all data from a citizen science program "Un Dragon dans mon jardin" without filter collected between 2013 and 2019; VOL: all additional data collected by volunteers in 2019; PRO: data collected by professionals. DET: 500m cells with detection of the species; NoDET: 500m nondetection-cells

	CS.1		CS.2		CS.1 + ABS + SUP		CS.2 + ABS + SUP	
	Nb of DET	**Nb of NoDET**	**Nb of DET**	**Nb of NoDET**	**Nb of DET**	**Nb of NoDET**	**Nb of DET**	**Nb of NoDET**
Anourans:								
Bufo spinosus	54	49	54	40	97	187	97	185
Hyla arborea arborea	56	65	56	59	136	204	137	203
Pelodytes punctatus	16	63	15	65	40	249	40	211
Rana dalmatina	80	42	81	34	186	162	187	159
Rana temporaria	9	57	11	57	17	231	16	228
Urodeles:								
Salamandra Salamandra terrestris	44	46	44	35	79	186	79	177
Triturus marmoratus	30	58	31	16	62	213	61	169
Triturus cristatus	17	71	19	21	52	241	53	198
Lissotriton helveticus	87	31	85	7	176	164	175	125

Table 4. Description of the filtered datasets for each of nine species used for external validation of habitat suitability models. CS.0: all data from a citizen science program "Un Dragon dans mon jardin" without filter collected between 2013 and 2019; SUP: all additional data collected by volunteers and by professionals in 2018-2019. CS.2 (or CS.1) + ABS (CS.2 (or CS.1) with 10% supplement absence cells in very unfavourable habitats). DET: 500m cells with detection of the species; NoDET: 500m nondetection-cells. Results for 1 interaction.

	STRAT_CS		STRAT_ALL	
	Nb data/strat for s2	Nb data/strat for s3	Nb data/strat for s2	Nb data/strat for s3
Anourans:				
Bufo spinosus	22	19	37	23
Hyla arborea arborea	17	11	42	23
Pelodytes punctatus	13	3	29	8
Rana dalmatina	18	19	38	30
Rana temporaria	9	10	8	15
Urodeles:				
Salamandra Salamandra terrestris	19	21	23	25
Triturus marmoratus	9	10	13	16
Triturus cristatus	18	14	37	25
Lissotriton helveticus	18	13	26	13

Table 5. Number of filtered data by stratification used for external validation of habitat suitability models (STRAT_CS and STRAT_ALL).

1.3. Sites selection for data complementation

All supplementary sites (263 ponds without fish) were selected randomly in order to complete 2 landscape gradients: woody element (hedges + woods) density and pond density. The 132 ponds that we monitored were distributed in six 30x30 km sectors and gradients were complete in each sector. Sites were randomly sampled so as to decorrelate pond density and woody element density which are naturally dependant in our region. A seventh 30x30 km sector was sampled with volunteers during three sessions (see Figure 1 and 2). Other sampled ponds were selected throughout the region to complete the 2 landscapes gradient according to existing data from 2013 to 2018 (e.g. in Figure 3).

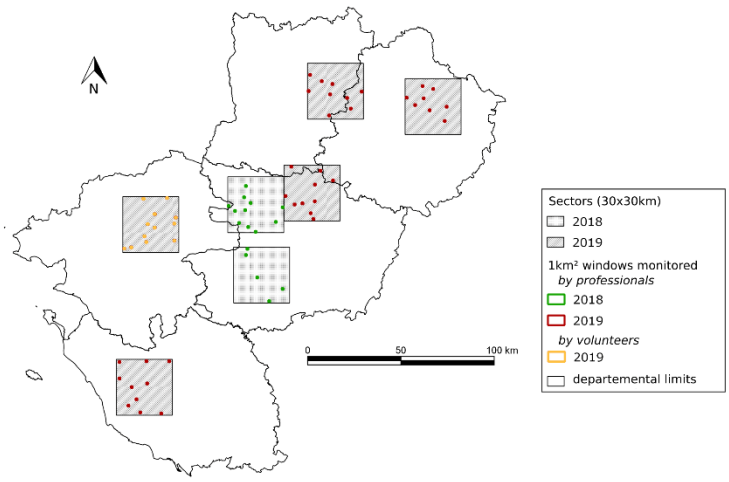

Figure 1. Sectors of 30x30km monitored by professionals or volunteers in 2018 or 2019. Gradients were complete in each sector and sites were randomly sampled so as to decorrelate pond density and woody element density. Three pounds without fish have been monitored in each windows of 1 km².

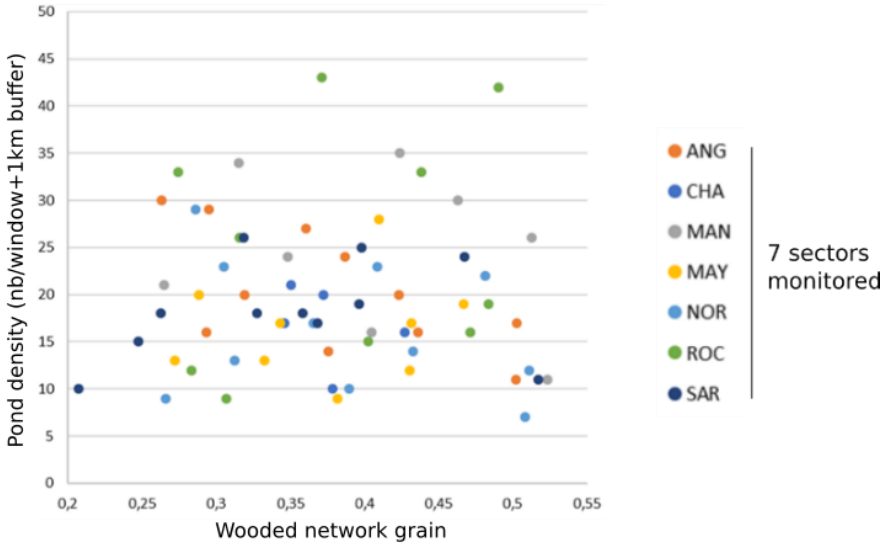

Figure 2. Repartition of the monitored windows by professionals or volunteers in 2018 or 2019 in the 7 sectors (30x30km²) along pond density and wooded elements density. Three pounds without fish have been monitored in each windows of 1 km². Volunteers monitored "SAR" sector and all others were monitored by professionals. Higher is "wooded network grain", lower is woody elements density.

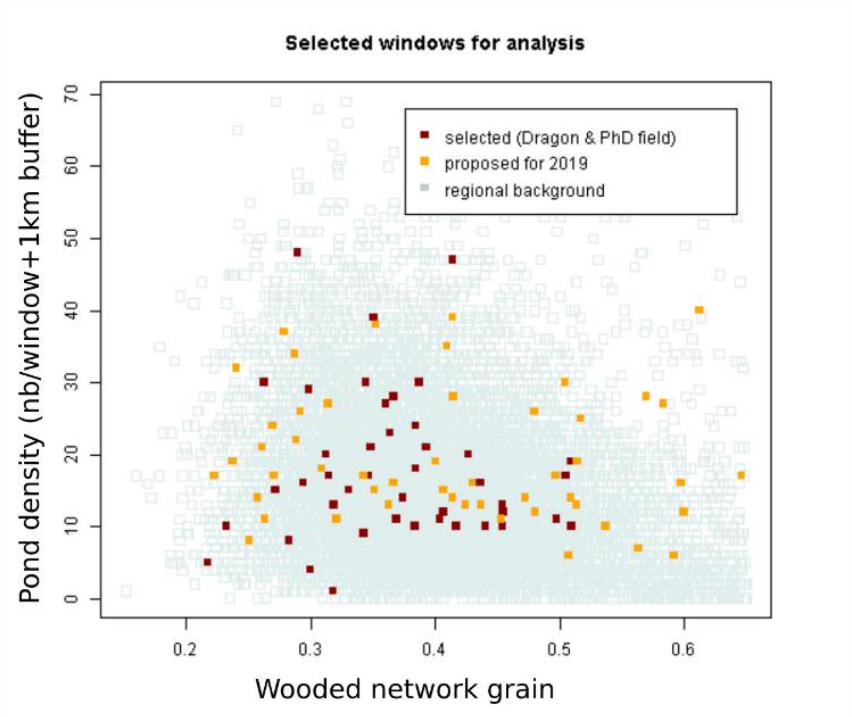

Figure 3. Example of proposed windows for monitoring by volunteers and their distribution along the two gradients (pond density and woody element density). Higher is "wooded network grain", lower is woody elements density. "selected" data were existing data in 2018 after strong filtering and before additional field.

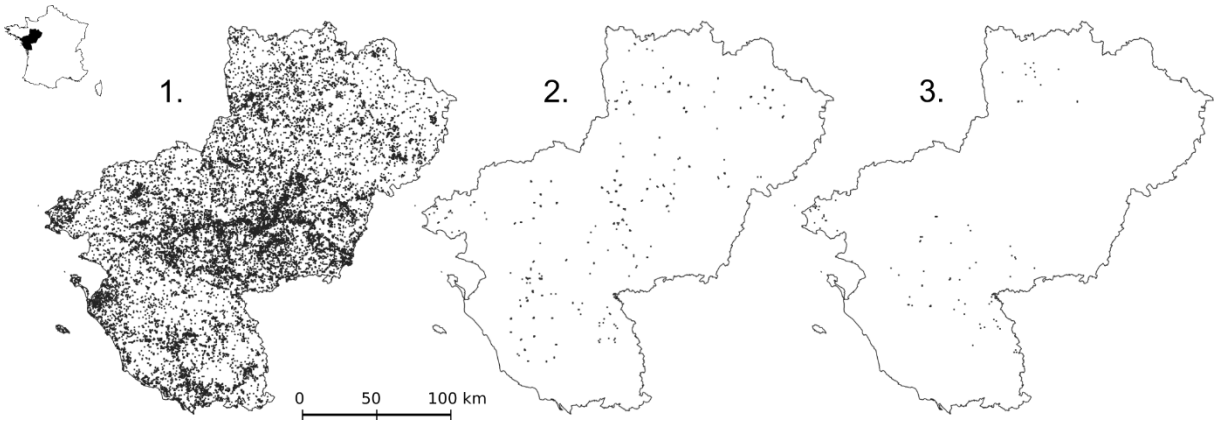

Figure 4. Distribution of the 500m² cells with data for the opportunistic dataset and the external evaluation dataset (e.g. *CS.1+ABS+SUP*). 1. All 500m² cells with at least one opportunistic observation (all species); 2. 500m² cells used as presence-absence data (with at least three surveys performed by an expert observer or six surveys by an intermediate observer) for external validation; 3. 500m² cells used only as presence if the species had been detected (sampling effort too weak for absence data) for external validation. The external dataset for validation is a compilation of 2. (presence-absence) and 3. (presence).

1.4. *Observation level and threshold values for the minimal sampling effort required to valid absence data for each species.*

Based on our observer classes, we set threshold values for the sampling effort needed to validate absence data (i.e. the minimal number of surveys called *N* and defined for each observer classes "expert", "intermediate" and "novice" called N_{exp}, N_{int} and N_{nov} respectively); absence data was validated when grid cells had been monitored by at least N_{exp} nocturnal surveys conducted by an "expert" observer or at least N_{int} nocturnal surveys by "intermediate" observer and at least N_{nov} surveys by a "novice" observer. N_{exp}, N_{int} and N_{nov} were defined according to four species detection classes: species easily detected (e.g. *Rana dalmatina* and *Hyla arborea*) with N_{exp}=2 N_{int}=2 and N_{nov}=4 ; species with medium detection rate with N_{exp}=2, N_{int}=3 and no N_{nov} (e.g. *Triturus cristatus* and *Lissotriton helveticus*) and species more difficult to detected with N_{exp}=3, N_{int}=4 and no N_{nov} (e.g. *Triturus marmoratus*, *Salamandra salamandra*, *Bufo spinosus* and *Pelodytes punctatus*) or with N_{exp}=3, N_{int}=5 and no N_{nov} (e.g. *Rana temporaria*). These classes were defined according to occupancy studies in France (Boissinot 2008 and Petitot et al., 2014) in Switzerland (Pellet et Schmidt 2005) and in UK with volunteers' surveys (Sewell et al. 2010). Difference between observers' groups were defined according to the species detection probability calculated for the monitoring methods used (i.e. acoustic, visual or direct sampling using a fishing net) by Boissinot 2008;

1.5. *Target species for absence validation (CS.2)*

Species	Target species for absence validation
Anourans:	
Bufo spinosus	At least one other species detected
Hyla arborea arborea	At least one other species detected
Pelodytes punctatus	At least one other species detected
Rana dalmatina	At least one other species detected
Rana temporaria	At least one other species detected
Urodeles:	
Salamandra Salamandra terrestris	*Triturus cristatus or Triturus marmoratus or Lissotriton helveticus*
Triturus marmoratus	*Triturus cristatus*
Triturus cristatus	*Triturus marmoratus*
Lissotriton helveticus	At least one other species detected

Table 6. Target species used for absence validation for each studied species