The relationship between habitats and amphibian populations in amphibian breeding sites of national importance

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TABLE OF CONTENTS:

1. Abstract

In recent decades, the biodiversity has been declining all around the world. Amphibians are the most threatened group of vertebrates with 40% of endangered species. In Switzerland, 70% of native species are on the Red List. In order to define and apply appropriate protection, management and restoration measures, it is necessary to determine the environmental factors influencing species occurrence. In this study, I analysed the influence of the habitat characteristics on site occupancy of 13 amphibian species in breeding sites of national importance in Switzerland. Amphibians and habitats data from 118 sites were used. By using occupancy modelling analyses, it was possible to identify the variables best explaining the probability of occupancy of the species. The results showed that the best model for explaining the probability of occupancy is different for each species. Variables describing the aquatic habitat were frequently included in the best models. An increase in water area as well as in the number of ponds generally had a positive effect. Terrestrial habitats were also important and were present on the best models for 11 of the 13 species studied. The terrestrial habitat variables most represented are fields, forest, ruderal and wetland area. Connectivity as well as past population were also recurring variables to explain the probability of species occupancy. The results can be used to improve management of the nature reserve in such a way that the persistence of amphibian species can be increased.

Keywords: Amphibians, conservation, occupancy models, Switzerland

2. Introduction

For many years, the biodiversity has been declining all around the world. The increase of the human population and the socio-economic issues linked to human population growth contribute to a very rapid loss of biological diversity relative to historical extinction rates (Wilson, 1992). More and more habitats are destroyed and degraded across the world as a result of land-use and land-cover change (Sun, 2017). Moreover, growing human population leads to more urbanization affecting ecosystems and is expected to continue to increase in the future (Hamer & McDonnell, 2008). Destruction and degradation of environment cause a reduction of connectivity between population and limits food resources, gene flow and metapopulation dynamics (Sun, 2017). As a consequence, population size is generally reduced and the probabilities of local extinction increases (Sun, 2017). Yet, research on the relationship between biodiversity and ecosystem functioning over the last twenty years has revealed that biodiversity is the driving force behind fundamental ecosystem processes and regulates their temporal and spatial stability (Eriksson & Hillebrand, 2020). Despite these issues, a lot of research is being conducted to determine the causes of biodiversity loss, but few studies are proposing solutions to the problems and even fewer are testing the proposed solutions (Grant et al., 2019)

In the last few years, amphibians decreased drastically and are currently the most threatened group of vertebrates with 40% endangered species (IUCN, 2019). Declining populations are due to a multitude of causes like pollution, introduction of invasive species, infectious diseases and climate change (Collins, 2010). Another major threat is the destruction and modification of the habitat (Hamer & McDonnell, 2008). During the 20th century, half of the world's wetlands were lost. This is largely due to drainage for increased agricultural production (OECD, 1996). This results in the drying up of wetlands and a decline in water levels and quality. The preservation, the creation and the enhancement of wetlands and water bodies is therefore of paramount importance for the protection of amphibians. In Switzerland, more than 90% of the wetlands have disappeared between 1850 and 2000 (Gimmi et al., 2011). The remaining wetlands are often of low quality and highly fragmented.

In Switzerland, where this study is being conducted, 19 native species are known to occur with 70% of native species that are on the Red List. In addition, for some of them, more than half of the population has disappeared in the last 30 years (Cruickshank et al., 2016).

Fortunately, protective measures have been taken to limit the disappearance of amphibian populations all around the world. The International Union for Conservation of Nature (IUCN) has designed an Amphibian Conservation Action Plan to provide guidance for implementing amphibian conservation and research initiative from the global to the local level. This action plan recommends that the highest priority be given to identifying, refining, prioritizing and safeguarding key sites for threatened amphibians (Gascon et al., 2007). In Switzerland, conservation efforts for amphibian began in the 1960’s (Schmidt & zumbach, 2019) and amphibian population and their habitat are protected by law since 1966. In 2001, the Swiss government published a list of ca. 800 amphibian breeding sites of national importance (IBN sites) (Ryser, 2002). These sites have to be protected by the cantonal conservation authorities.

For conservation measure, it is important to understand how environmental factors influence the biodiversity. A previous study has shown that the occurrence of most species was influenced by environmental covariates at local and landscape scale (Van Buskirk, 2005). To illustrate that, environmental factors like the altitude can be related to biodiversity in Swiss ponds. Indeed, a decrease in species richness is associated with an increase of the altitude (Oertli et al., 2000). Many other factors are related to biodiversity loss and it is important to determine which ones are relevant to the species studied. In addition to the knowledge of which factors are important for each species, it is essential to determine threshold values. Several studies show values at which species are or not present in a specific environment. For example, a study by Riley et al. (2005) found that two species of amphibians were conspicuously absent from streams where the watershed was covered with >8% urban land uses. Finding these values is therefore essential in order to restore, manage or create habitats adapted to the target species.

The purpose of this master thesis is to analyse by using occupancy models analyses the influence of the habitat characteristics in amphibian breeding sites of national importance of Switzerland on the site occupancy of amphibians. This is important in order to deepen knowledge about the needs of species and to improve conservation action. In order to define and apply appropriate conservation, management and restoration measures, it is necessary to determine the environmental factors influencing species diversity and occurrence (Hinden et al. 2005). Indeed, for conservation purposes, studying the distribution of species richness in various habitats and their ecological determinants is an essential step in understanding the mechanisms that affect the spatial distribution of biological diversity and in predicting the response of ecosystems to global changes (Soares et al., 2007).

I chose to use model selection analyses because it allows to analyse several hypotheses at the same time and to rank them according to their importance and their weight on the probability of occupation of the species (Shenk & Franklin, 2001). A set of candidate models was developed based on the environmental variables to be tested in order to find the most important factors to explain the occupancy probability for each species and to determine threshold values. For example, this allows us to know the optimal sizes of breeding ponds in order to build new ones for a given endangered species. Analyses of all stages of the species as well as the analysis of only the larval stage have been done. It is important to separate the two in order to know in which environments species reproduce and those in which the species is just present. In order to achieve that, a multitude of data is used and analysed. As part of the monitoring of the implementation of amphibian breeding site protection, the IBN advisory service (the consultants responsible for the federal inventory of amphibian breeding sites of national importance) mapped amphibian habitats in 113 randomly selected sites in all of Switzerland. The mapping is based on the classification of natural habitats types according to TypoCH (Delarze et al. 2015) and took place between 2016 and 2018. This mapping allows us to have information on the type of habitat, the surface area of each habitat type as well as the number and type of water points. I used WBS data (a monitoring of amphibian population in all sites of national importance; Bergamini et al., 2019) to establish a link between habitats and amphibian occurrence an abundance. The WBS data include data on the presence/absence of the species as well as their larval stages. The 113 randomly selected locations will be completed by five other locations which will be mapped and monitored by myself.

In this work, there are three main hypotheses that I would like to test:

- The surface area of the object, the past population size and the connectivity will be very important variables for explaining the probability of occupancy of species.

- Aquatic environment variables such as surface of freshwater area and number of ponds will be the most influential environment variables in explaining species detection/non-detection. These are the habitat limiting factors. In other words, these factors limit the growth and distribution of the population in that habitat.

- The variables related to the aquatic habitat will be the environmental variables that best explain the occupancy of the larval stage.

These hypotheses are the same for each species studied in this work. Even though the different species do not share the same environmental needs, the most important factors will be similar. This is because most amphibian species require water for reproduction. The number of ponds and their surface, as well as the different types of water, are therefore essential for the size of amphibian populations and are the most important factors. Other factors such as the surface of forest may also play a more or less important role depending on the species natural history.

3. Material and methods

3.1 TYPE OF DATA AVAILABLE

Different types of data were available for my master thesis. The data that I used were:

Amphibian data:

- WBS amphibian data
- Detection/non-detection of species
- Detection/non-detection of reproductive stages (larvae)

Explanatory variables:

- Habitat data (number of ponds, size of pond, freshwater area, forest area…)
- Presence in the past (2001)
- Connectivity
- Altitude

The first two data sets (WBS amphibian data and habitat data) are the most important for the analysis of species-habitat relationships. The other variables are of biological interest as well, but they also serve as a “control” for the habitat variables.

3.2 WBS AMPHIBIAN DATA

Amphibian data was provided by info fauna karch. This is a monitoring of amphibian populations in sites of national importance for the purpose of monitoring the impacts of biotope protection in Switzerland (WBS) (Bergamnini et al. 2019). These data were collected between 2013 and 2019 by experienced herpetologists throughout Switzerland. These data include the detection/non-detection of species and larvae. In this master thesis, WBS data from 113 sites were used and 5 were surveyed additionally by myself. The 113 sites were selected because habitat mapping data for these sites was available. The location of these sites is shown in figure 1. In order to make all data comparable, a protocol was established:

- Four visits are made once a month for each location between March and June. These visits are carried out when the conditions are right to observe the expected species and in greater numbers (mild nights without rain or wind and avoiding prolonged droughts). The phenology of the species must therefore be taken into account.

- In each area, the ponds are surveyed for amphibians. If some areas are too large, the effort has been concentrated in the areas most suitable for amphibians. It is possible to consult these zones on the Map.geo.admin.ch website.

- The duration of each visit must be a minimum of one hour and each species and its different life stages are noted and counted (larvae, adults, singing male). As the counting of larvae and tadpoles is difficult, they will only be described as an absence/presence level. All data is then entered into an Excel file.

- Three detection methods can be used: Landing nets, eye observation with a flashlight, and detection of calling animals. For each method, unnecessary stress to the animal should be avoided and care should be taken to ensure that its welfare is not compromised. The amphibians found during my visits were detected by eye observation and detection of calling animals.

- Uncertainties of determination are noted to avoid false identifications. No distinction is made between *Pelophylax esculentus* and *Pelophylax lessonae* and are reported as *Pelophylax sp.* Laughing Frogs (*Pelophylax ridibundus*) are reported only if they can be reliably identified.

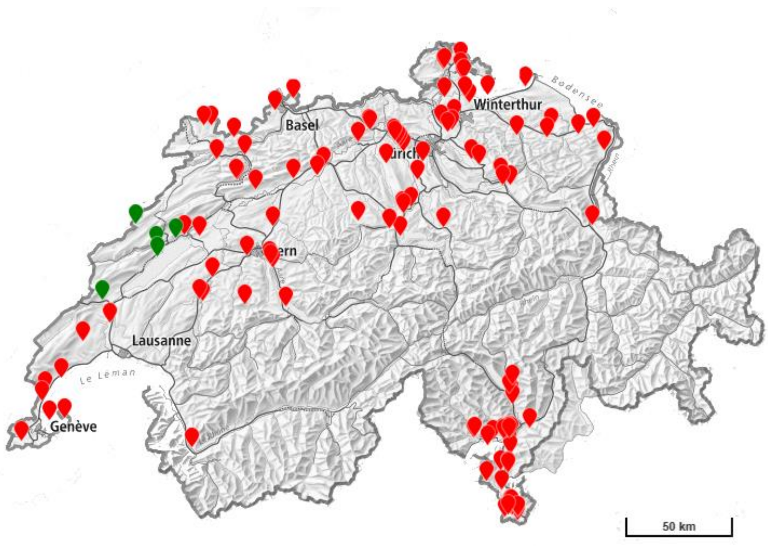

FIgure 1 : Location of the 118 sites of importance national used in this study. Red points are the sites where amphibian data was collected as part of the WBS monitoring program and green points are sites where data was collected by myself**.**

3.3 HABITAT DATA

The habitat data were provided by the IBN advisory service. These data were collected as part of the campaign to assess the status of sites of national importance. Data from 113 sites were provided by the IBN service. I collected habitat data at five sites myself. In total, data from 118 sites were used on this master thesis. The locations corresponding to the habitat data are the same as those used for the amphibian data (figure 1).

These data were collected in the field through environmental mapping work. This mapping work is based on 3 elements: the mapping of habitats over the entire perimeter of the object (amphibian breeding area (perimeter A) + buffer zone and terrestrial habitat adjacent to the breeding water body (perimeter B)), the description of water bodies and other larval habitats (essentially for perimeter A) and the mapping of threat like roads or buildings (perimeter A + B). The mapping is carried out according to the following protocol:

- Mapping is carried out during the appropriate season (March to August) with a preference for the amphibian breeding period (April to July).

- The cartography is done on orthophotos (colours) at a scale of 1:2'500. The whole perimeter is treated as well as a border of about 20-30m if the object does not follow a boundary clearly demarcated by the terrain. If the boundary is clear (road, watercourse) the mapping of an additional fringe is not necessary.

- The habitat typology is based on natural habitats in Switzerland (Delarze et al. 2015, see annex 1).

- Only habitats larger than 100 m2 are mapped (~ 10 x 10 m minimum size) except temporary or permanent water bodies and all aquatic larval development areas. Flooded meadows in which amphibians regularly reproduce are considered water bodies.

- Water bodies and other wetlands are mapped in priority over terrestrial environments. The description of water bodies is based on the average level during the breeding season (April to July) and is described in detail in a separate field sheet (see Annex 2).

- The mapping of damage is done on the same scale as that of the habitats (1:2'500). The typology of damage is that of the ''Eingriffsdatenbank'', a database of biotopes in Switzerland (see Annex 3).

3.4 CONNECTIVITY

To quantify the importance of connectivity on amphibian detection/non-detection, I used the connectivity metric described by Zanini et al. (2009). Connectivity variables describe the distribution and occupancy status of water bodies in a buffer zone around the sites of interest for each species. To calculate connectivity, I used information from the national database of info fauna karch (Schmidt and Zumbach, 2019). This database contains records of more than 12,000 amphibian breeding sites and more than 160,000 amphibian sightings (Schmidt & Zumbach, 2019).

One connectivity variable was calculated: A measure of connectivity based on metapopulation theory. This measure is called CONNECT (Zanini et al., 2009). Metapopulation theory is used to create a distance-weighted measure of the number of occupied water bodies within 5 km of focal sites, such as:

$$CONNECT_i = \sum_{j \neq i} e^{(-d_{ij})} y_j \Big/ \sum_{j \neq i} e^{(-d_{ij})}$$

d_{ij} is the distance (in km) between patches *i* and *j*, and y_j is a binary variable specifying whether patch *j* is occupied by the focal species.

3.5 SPECIES STUDIED

There are 19 species of amphibians in Switzerland. In this study, not all species will be analysed. We decided to analyse data of 13 ponds-breeding species (shown in table 1), including some that are less common. Rare species often are the most endangered species, so it is still important to analyse the data to try and identify the best way to protect them. Green frogs are difficult to differentiate and can hybridize (*Pelophylax lessonae, Pelophylax esculentus and Pelophylax ridibundus*). They are therefore all included in *Pelophylax sp.*

Species	Red List status
Alytes obstetricans	EN
Bombina variegata	EN
Bufo Bufo	VU
Epidalea calamita	EN
Hyla arborea	EN
Hylia intermedia	EN
Pelophylax sp.	LC
Rana dalmatina	EN
Rana temporaria	LC
Lissotriton helveticus	VU
Lissotriton vulgaris	VU
Ichthysaura alpestris	LC
Triturus carnifex	EN

Table 1: **List of species that will be analysed on this study.** The column ‘red list status’’ represents the conservation status of the species in Switzerland: LC = least concern, VU = vulnerable, EN = endangered.

3.6 DATA ANALYSES

First of all, a correlation matrix between the environmental variables and the total surface area of the sites was created in order to determine whether there is a relationship between them. This was done using the 'corrplot' function in package 'corrplot' in R software (Version 1.1.456) (Fiske & Chandler, 2011).

Analyse of detection/non-detection of all stages:

To analyse the data based on detection/non-detection, the patch occupancy model by MacKenzie et al. (2003) was used. This model allows to estimate and correct imperfect detection. Indeed, a non-detection does not mean that the species is necessarily absent. All species and individuals are rarely detected perfectly, regardless of the techniques used (Bailey and Adams, 2005). Particularly for amphibians, detectability may vary from one study site to another, depending on ease of access, size of the site as well as weather conditions. These models use information from repeated observations at each site to estimate detectability (Bailey and Adams, 2005). Moreover, with this model, we can include some covariate, which makes it a robust statistical model and allows to examine the relationship between amphibian population and habitat factors. (Rovero et al., 2010)

This model calculates the probability ψ that a site is occupied by the target species in function of site-specific covariates. To do that, we need the detection histories (Hi). It is a record of whether or not the target species were detected on each survey of each site. We got this information from the WBS amphibian observation. The presence of a species is marked with a 1, while the absence is marked with a 0. For example, if a species was detected on the first and second survey (p1 and p2) and not detected at the third and last survey (p3 and p4), we can write the probability of detection as:

$$Pr(Hi = 1100) = \psi \times p1\ p2\ (1 - p3)(1 - p4)$$

Then, some covariates will be added. These covariates information can be easily introduced to the model using a logistic regression model (MacKenzie et al., 2002). The covariates used in each model are shown below (table 2) and these site-specific covariates do not change during the survey. Several models using different covariates will be tested and are the same for each species. These models are shown in table 3. The occupancy models were fitted using the 'occu' function in package 'unmarked' in R software (Version 1.1.456) (Fiske & Chandler, 2011). Models that generate errors are removed from the analysis (e.g. models that do not converge). After testing the models in R program, a final model including the combination of variables having the greatest effect on the probability of occupancy was developed. Important variables are highlighted using the command 'importance' from the 'MuMIn' package. Finally, Model selection was made using Akaike's information criterion (AIC; Akaike, 1973). Models with lower AICc are considered best. The Akaike weights was also calculated in order to complete the analysis. The sum of the Akaikes weight of all models is 1. This makes it possible to know how good the best model is compared to the second. Also, tables with parameter estimates of the explanatory variables of the AICc-best model for each species was done to determine if the environmental variables in the models are significant (P-value < 0.05).

Missing values can easily be taken into account by their model. If an observation is missing, the corresponding detection probability is zero. This is because the missing observation does not contribute to the model probability. (Mackenzie and Bailey, 2004)

Data of the 118 sites are used for the analyses except for two species (*Hyla intermedia* and *Triturus carnifex)* for which 34 of the 118 sites were used. These two species only occur in the canton of Ticino, so it was not relevant to include data from other cantons in their analyses.

Analyse of detection/non-detection of larval stages:

The analysis of detection/non-detection of the larval stage is also done with the patch occupancy model by MacKenzie et al. (2003). However, only sites with detection of larvae and other stages are used. Indeed, the aim is to see which variables affect the reproduction of the species. It therefore makes no sense to include sites where the species have not been detected. To do that, a matrix is created with the data of all stage and larval stage. This first matrix contains three values: 0 means that no stage of the species was detected at the site, 1 means that another stages than larvae was detected at the site, and 2 means that a larvae was detected at the site. I then removed all the sites with only 0. Finally, another matrix is created where the non-detection of larvae on sites, but the detection of another stage is marked with 0, while the detection of larvae on sites is marked with 1.

The occupancy models are then fitted and selected with the same method as for the analysis of all stages. Contrary to the analyse of all stages, models do not contain the variables past population and connectivity, but these two variables are still tested in two separate models (table 3).

Table 2: Abbreviation of the variable use in occupancy models analysis. The habitat variable is based on natural habitats in Switzerland (Delarze et al. 2015). A more complete description of this habitat variables can be found in the appendix 1.

Abbreviation	Meaning
Past.pop	Past population (presence or absence in the past (2001))
Connect	Connectivity
TotalS	Total surface of the site [ha]
Altitude	Altitude of the site [m]
Water.a	Surface of water within site (freshwater and flowingwater) [ha]
Num.ponds	Number of ponds within site
Freshwater.a	Surface of freshwater within site [ha]
Freshwater.prop	Proportion of freshwater within site [%]
Build.a	Surface of build area within site (surface of landfills, building, roads, paved sports field, parking space…) [ha]
Build.prop	Proportion of build area within site [%]
Wetland.a	Surface of wetland area within site (surface of artificial shores, reed beds, low marshland, wet meadow and domed bog) [ha]
Wetland.prop	Proportion of wetland area within site [%]
Meadow.a	Surface of meadow area within site (surface of artificial lawns and meadows, thermophilic dry lawns, lawns and low-lying pastures and oily meadows) [ha]
Meadow.prop	Proportion of meadow area within site [%]
Lands.a	Surface of lands area within site (surface of herbaceous edges, megahorberry groves, forest cuts, bush formation and lands) [ha]
Lands.prop	Proportion of lands area within site [%]
Forest.a	Surface of forest within site (surface of plantation, floodable forest, beech woods, other deciduous forests, thermophilic pine forests, peat bog forests and coniferous forest) [ha]
Forest.prop	Proportion of forest area within site [%]
Field.a	Surface of field area within sites (surface of cultivation of woody and herbaceous plants) [ha]
Field.prop	Proportion of field area within site [%]
Ruderal.a	Surface of pioneer vegetation in man-made disturbed areas (Trampled and ruderal plots of land) [ha]
Ruderal.prop	Proportion of pioneer vegetation within site [%]
Num. Temporary ponds	Number of temporary ponds within site

Table 3: Patch occupancy analysis models use for the analyses of all stages and larval stage. Abbreviations of the variable are explained in the table 2. Ψ is the occupancy probability and p is the detection probability. The first model contain no covariate.

	Models for all stages	Models for larval stage
Model 1	Ψ(.)p(.)	Ψ(.)p(.)
Model 2	Ψ(past.pop + connect + TotalS)p(.)	Ψ(TotalS)p(.)
Model 3	Ψ(Altitude + past.pop + connect + TotalS)p(.)	Ψ(Altitude + TotalS)p(.)
Model 4	Ψ(water.a + past.pop + connect + TotalS)p(.)	Ψ(water.a + TotalS)p(.)
Model 4.1	Ψ(water.a + water.a^2+ past.pop + connect + TotalS)p(.)	Ψ(water.a + water.a^2 + TotalS)p(.)
Model 5	Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	Ψ(Num.ponds + TotalS)p(.)
Model 5.1	Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	Ψ(Num,ponds + Num.ponds ^2 + TotalS)p(.)
Model 6	Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	Ψ(Freshwater.a + TotalS)p(.)
Model 6.1	Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)
Model 7	Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	Ψ(Freshwater.prop)p(.)
Model 7.1	Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)
Model 8	Ψ(Build.a + past.pop + connect + TotalS)p(.)	Ψ(build.a + TotalS)p(.)
Model 9	Ψ(Build.prop + past.pop + connect)p(.)	Ψ(buil.prop)p(.)
Model 10	Ψ(wetland.a + past.pop + connect + TotalS)p(.)	Ψ(wetland.a+ TotalS)p(.)
Model 11	Ψ(Wetland.prop + past.pop + connect)p(.)	Ψ(wetland.prop)p(.)
Model 12	Ψ(meadow.a + past.pop + connect + TotalS)p(.)	Ψ(meadow.a + TotalS)p(.)
Model 13	Ψ(meadow.prop + past.pop + connect)p(.)	Ψ(meadow.prop)p(.)
Model 14	Ψ(lands.a + past.pop + connect + TotalS)p(.)	Ψ(lands.a + TotalS)p(.)
Model 15	Ψ(lands.prop + past.pop + connect)p(.)	Ψ(lands.prop)p(.)
Model 16	Ψ(forest.a + past.pop + connect + TotalS)p(.)	Ψ(forest.a + TotalS)p(.)
Model 17	Ψ(forest.prop + past.pop + connect)p(.)	Ψ(forest.prop)p(.)
Model 18	Ψ(field.a + past.pop + connect + TotalS)p(.)	Ψ(field.a + TotalS)p(.)
Model 19	Ψ(field.prop + past.pop + connect + TotalS)p(.)	Ψ(field.prop)p(.)
Model 20	Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	Ψ(ruderal.a)p(.)
Model 21	Ψ(Ruderal.prop + past.pop + connect + TotalS)p(.)	Ψ(ruderal.prop)p(.)
Model 22	Ψ(Num.Temporary ponds + past.pop + connect + TotalS)p(.)	Ψ(Num.Temporary ponds)p(.)
Model 23	-	Ψ(connect)p(.)
Model 24	-	Ψ(Past.pop)p(.)

4. Results

A correlation analysis between the different explanatory variables shows that all variables are positively correlated. The total surface area of the sites is highly correlated with all environmental variables. Only the number of temporary ponds shows a weak correlation with the total surface, but the number of permanent and temporary ponds shows a much higher correlation. The freshwater surface, the meadow surface as well as the forest surface are the most correlated to the total surface area (figure 2).

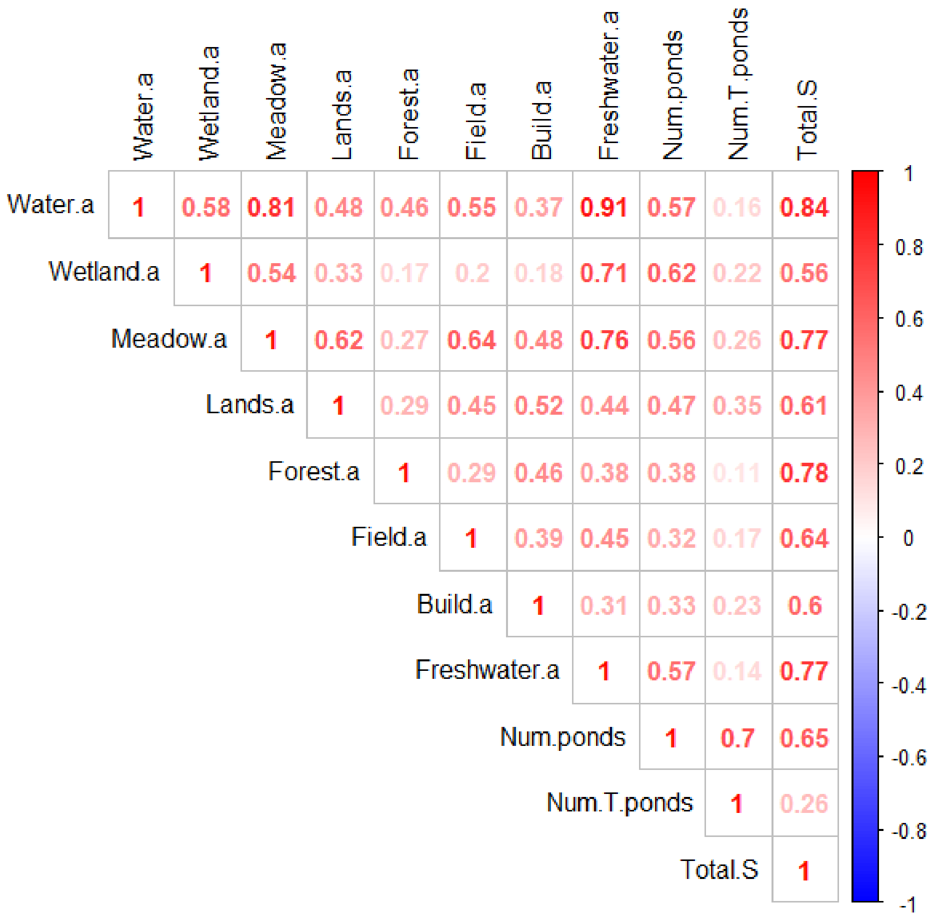

Figure 2: Correlation plot of all environmental variables with the total surface. Red shows positive correlations while blue shows negative correlations. The closer the correlation coefficient is to 1, the stronger the correlation between the two variables. Num. T. ponds is the number of temporary ponds. Others abbreviation are explained on the table 2.

The results of the presence/absence analyses for each species are shown below. I only made the relevant graphs according to the best models, with significant environmental variables (P-value < 0.05) or close. Models with lower AICc are considered best

ALYTES OBSTETRICANS

The model selection results for *Alytes obstetricans* are shown in table 4.

Table 4: **Model selection results of the occupancy analysis for *Alytes obstetricans* for the two analyses (all life history stages and only larvae).** Ranking and weighting is according to AICc. Only candidate models with a w > 0.1 are shown. A full model selection list for each species can be found in the annex 4. Abbreviations of explanatory variables are explained in method section in table 2. In this table, K is the number of parameters in the model, logLik is the log-likelihood of the model, AICc is the small-sample Akaike information criterion, ∆AICc is the difference between a model and the model with the lowest AICc value and w is the Akaike weight.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(wetland.prop + ruderal.prop +past.pop + connect)p(.)	6	-56.14	125.03	0	0.720
Ψ(wetland.prop + past.pop + connect)p(.)	5	-58.44	127.41	2.383	0.219
Larval stage					
Ψ(.)p(.)	2	-35.88	76.76	0	0.174
Ψ(field.prop)p(.)	3	-34.46	77.1	0.336	0.147

The best model for the occupancy probability of detection/non detection of *Alytes obstetricans* all stages is: Ψ (wetland.prop + ruderal.prop + past.pop + connect)p(.). The sum of the Akaike weights for the two best models represent almost the maximum of the Akaike weight (0.720 + 0.219 =0.939) (Table1) and the best model is 3.3 times (0.720/0.219) more likely than the second ranked model.

For the larval stage, the best model is the one with no covariates. The Akaike weight is small for the best model. Akaike weights are similar for many models, suggesting that there is substantial model selection uncertainly.

Table 5: **Parameter estimates of the explanatory variables in the AICc-best model for *Alytes obstetricians*.** SE is the standard error.

	Estimate	SE	P-value
Intercept	-2.80	0.971	0.00391
Wetland proportion	-1.4007	0.8033	0.08124
Ruderal proportion	0.0485	0.0238	0.04177
Past population	2.18	0.759	0.00406
Connectivity	1.21	1.439	0.39943

There is a negative effect of wetland proportion on occupancy probability (table 5). As shown in figure 3.a, the occupancy probability drops to 0 when there is more than 3% of wetland area in the site.

The results showed a positive effect of the ruderal proportion on the occupancy probability of *Alytes obstetricans* all stages (table 5). However, this positive effect is very small and cannot be seen on the graph (figure 3.b).

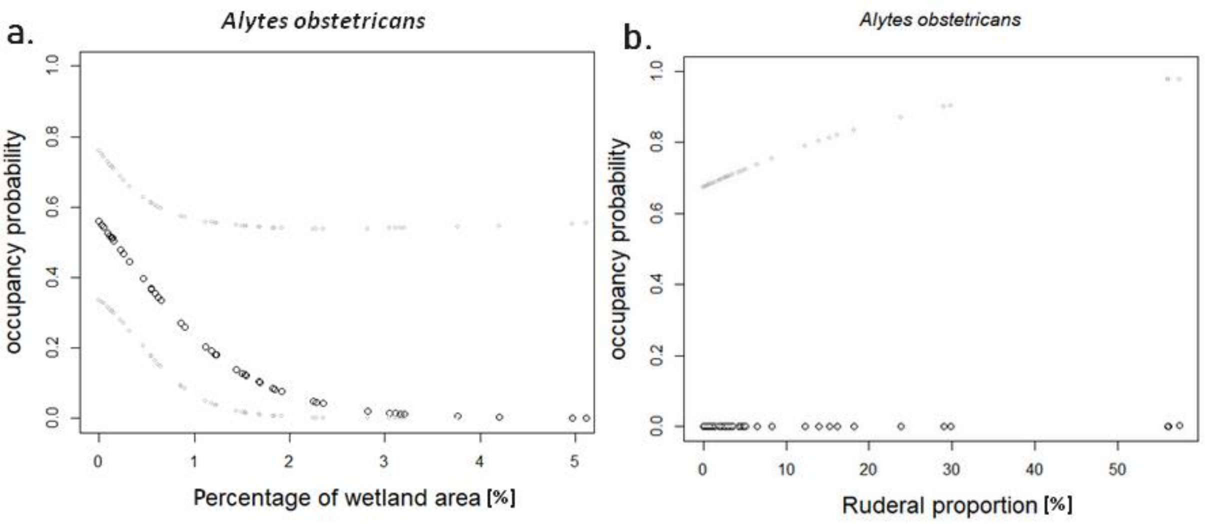

Figure 3: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Alytes obstetricans* all stages. The graph a represents the relationship between the proportion of wetland area [%] within a site and the occupancy probability. The graph b represents the relationship between the proportion of ruderal area [%] within a site and the occupancy probability. The relationship is based on the AICc-best model in table 4. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

RANA TEMPORARIA

The model selection results for *Rana temporaria* are shown in table 6.

Table 6: **Model selection results of the occupancy analysis for *Rana temporaria* for the two analyses (all life history stages and only larvae).** The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(connect + past.pop + Freshwater.prop + Altitude) p(.)	6	-268.11	548.97	0	0.935
Larval stage					
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-218.53	447.77	0	0.292
Ψ(connect)p(.)	3	-220.95	448.17	0.4	0.239
Ψ(wetland.prop)p(.)	3	-221.25	448.77	0.999	0.177

The best model for the occupancy probability of detection/non detection of *Rana temporaria* all stages is: Ψ (connect + past.pop + Freshwater.prop + Altitude)p(.). The Akaike weight for the best model represent almost the maximum of the Akaike weight (0.935) (table 6). In this model, the variables freshwater proportion and altitude present a p-value < 0.05 and are therefore significant (table 7).

For the larval stage, there are 3 models with a high Akaike weight which represent almost the maximum of the maximum weight (0,708). The best model is 1.2 times (0.292/0.239) more likely that the second ranked model and 1.6 times (0.292/0.177) that the third one. In the best model, the standard error of water area and water area^2 is high, suggesting that the data may have some notable irregularities for this variable.

Table 7: **Parameter estimates of the explanatory variables in the AICc-best model for *Rana temporaria***. SE is the standard error.

Rana temporaria all stages

	Estimate	SE	p-value
Intercept	-4.81558	1.26289	0.000137
Connectivity	1.96898	1.16885	0.092075
Past population	1.26675	0.78105	0.104835
Freshwater proportion	0.33452	0.16050	0.037134
Altitude	0.00831	0.00293	0.004570

Rana temporaria larval stage

	Estimate	SE	p-value
Intercept	3.219	1.364	0.0322
Water area	-5.217	2.339	0.0257
Water area^2	16.148	9.212	0.0796
Total surface	-0.177	0.476	0.7105

The results showed a positive effect of the altitude on the occupancy probability of *Rana temporaria* all stages (table 6). As shown in figure 4.a, the occupancy probability increase with the augmentation of the altitude and reaches 1 when the site is more than 600 [m] of altitude.

For the proportion of freshwater on sites, I found a positive effect on occupancy probability (table 6). Occupancy probability increases with the augmentation of the proportion of freshwater on sites and reaches 1 when the site presents more than 10% of freshwater area (figure 4.b).

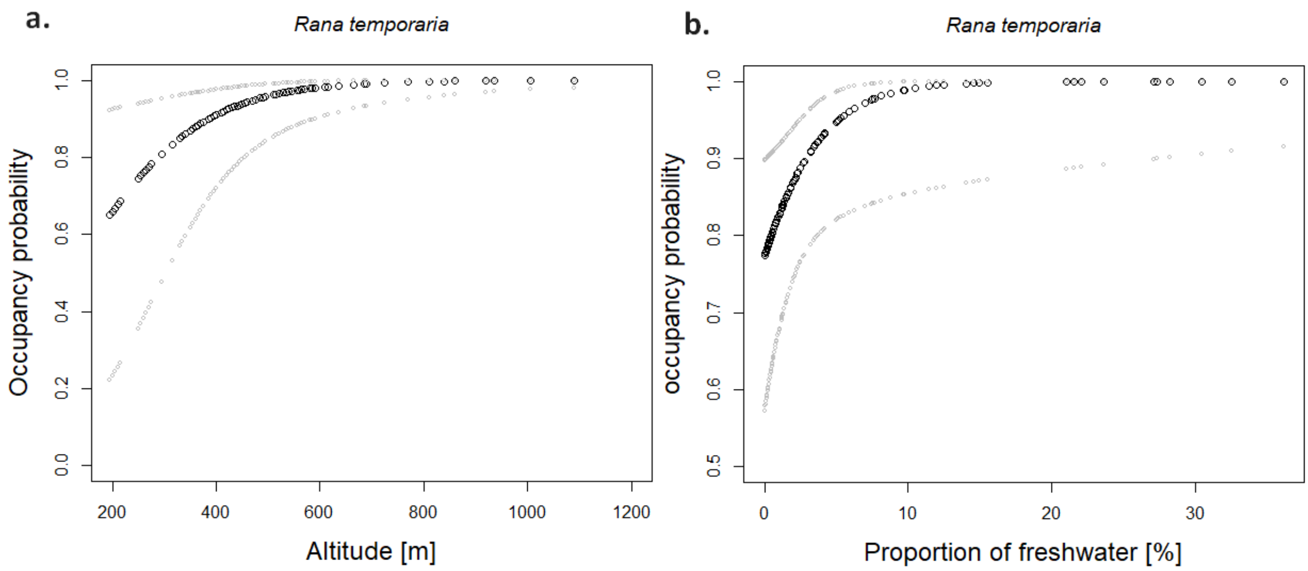

Figure 4: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Rana temporaria* all stages. The graph a represents the relationship between the altitude [m] within a site and the occupancy probability. The graph b represents the relationship between the proportion of freshwater [%] within a site and the occupancy probability. The relationship is based on the AICc-best model in table 6. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

BOMBINA VARIEGATA

The model selection results for *Bombina variegata* are shown in table 8.

Table 8: **Model selection results of the occupancy analysis for *Bombina variegata* for the two analyses (all life history stages and only larvae)**. The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Temporary ponds + past.pop + field area + ruderal.prop TotalS)p(.)	7	-106.07	227.15	0	0.951
Larval stage					
Ψ(Altitude + TotalS)p(.)	4	-39.42	88.83	0	0.135
Ψ(TotalS)p(.)	3	-40.92	88.98	0.144	0.126
Ψ(.)p(.)	2	-42.27	89.09	0.257	0.119

The best model for occupancy probability of detection/non detection of *Bombina variegata* all stages is: Ψ(Temporary ponds + past.pop + field area + TotalS)p(.). The Akaike weight for the best model represent almost the maximum of the Akaike weight (0.951) (table 8). In this model, the temporary ponds variable has a p-value < 0,05 and is therefore significant (table 9). The field area variable is almost significant.

For the larval stage, the Akaike weight is not very high for the first model and is distributed among all the models, suggesting that there is substantial model selection uncertainty. Also, Standard error and p-value are high for each variable of the best model, suggesting that the data may have some notable irregularities and can not be used for this analyse.

Table 9: **Parameter estimates of the explanatory variables in the AICc-best model for *Bombina variegate.*** SE is the standard error.

Bombina variegata all stages.

	Estimate	SE	P-value
Intercept	-3.7081	0.72766	0.000000347
Number of temporary ponds	0.1076	0.05304	0.04247
Past population	2.2741	0.66840	0.000668394
Total surface	0.0164	0.00764	0.03218
Field area	-0.1247	0.06776	0.06561
Ruderal proportion	0.0678	0.02614	0.009539

Bombina variegata larval stage.

	Estimate	SE	P-value
Intercept	18.7	65.8	0.776
Altitude	-13.4	45.1	0.767
Total surface	-13.4	54.7	0.806

The results showed a positive effect of the number of temporary ponds on the occupancy probability of *Bombina variegata* all stages (table 9). As shown in figure 5.a, the occupancy probability increases with the augmentation of the number of temporary ponds on the sites.

Regarding the surface of field area on sites, I found a negative effect on the occupancy probability of *Bombina variegata* all stages (table 9). The occupancy probability decreases with the augmentation of the surface of field area on sites and drops to 0 when the site contains more than 30 hectares of field (figure 5.b).

As shown in figure 5.c, the occupancy probability increase with the augmentation of the proportion of ruderal surface within site.

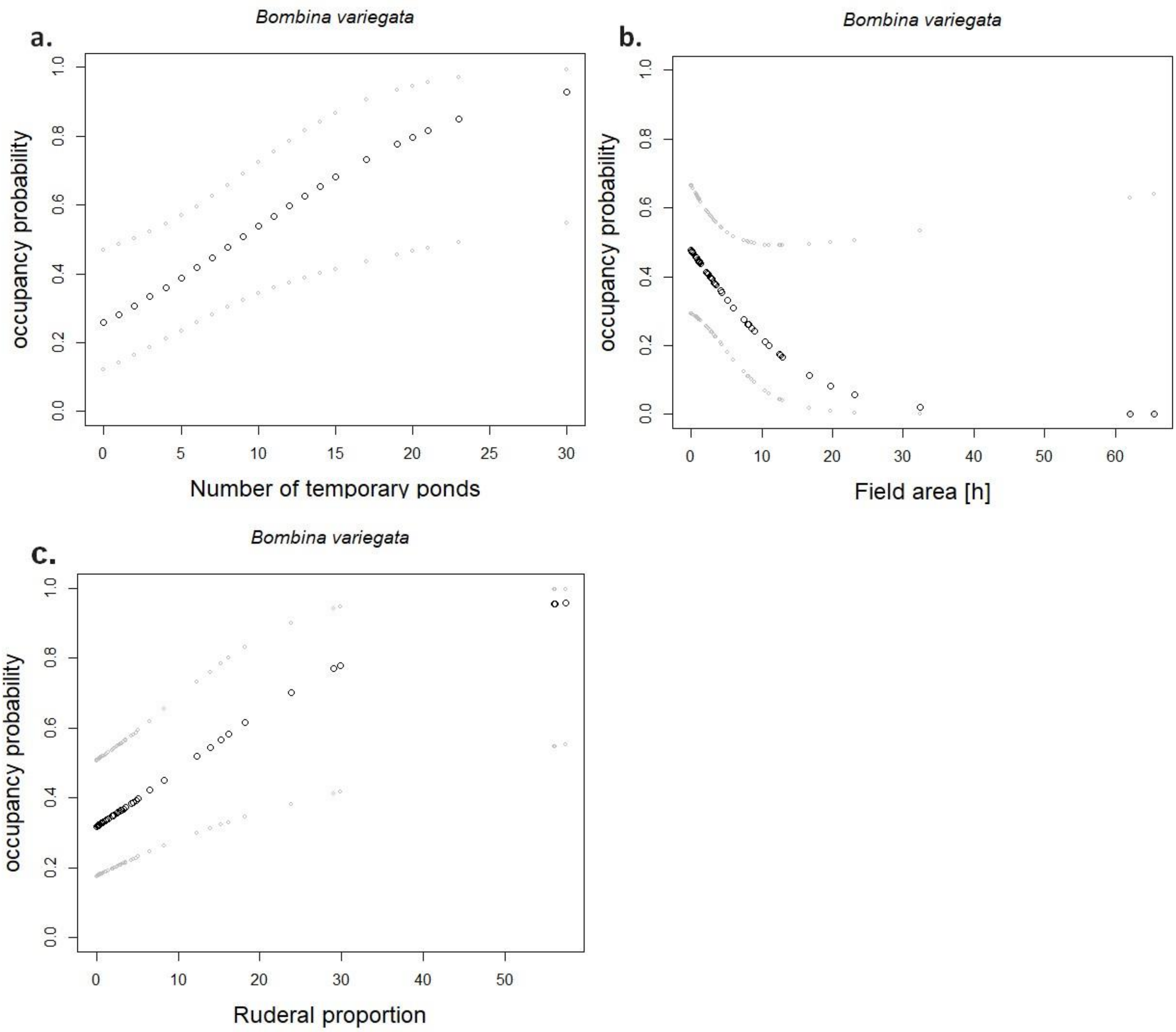

Figure 5: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Bombina variegata* all stages. The graph a represent the relationship between the number of temporary ponds within a site and the occupancy probability. The graph b represents the relationship between the field area (in hectares) within a site and the occupancy probability. The graph c represent the relationship between the proportion of ruderal area within site dans the occupancy probability. The relationship is based on the AICc-best model in table 8. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

BUFO BUFO

The model selection results for *Bufo bufo* are shown in table 10.

Table 10: **Model selection results of the occupancy analysis for *Bufo bufo* for the two analyses (all life history stages and only larvae).** The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Water.a + Freshwater.prop + past.pop)p(.)	5	-279.09	568.71	0	0.796
Larval stage					
Ψ(Wetland.a)p(.)	3	-189.5	385.29	0	0.440
Ψ(Wetland.a + TotalS)p(.)	4	-189.29	387.06	1.771	0.181

The best model for occupancy probability of detection/non detection of *Bufo bufo* all stages is: Ψ(Water.a + Freshwater.prop + past.pop)p(.). The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.796) (table 10). In this model, the variables are not significant, but the second and third models, which include the same variables, are significant. These variables therefore help to explain the probability of occupancy of the species within the sites.

For the larval stage, the Akaike weight for the first model is 2.4 times (0.440/0.181) more likely that the second ranked model. The same environmental variable are included in both models and are significant (table 11).

Table 11: **Parameter estimates of the explanatory variables in the AICc-best model for *Bufo bufo*.** SE is the standard error.

Bufo bufo all stages.

	Estimate	SE	P-value
Intercept	-0.611	0.4510	0.1756
Past population	1.240	0.5025	0.0136
Freshwater proportion	0.162	0.0989	0.1013
Water area	0.457	0.3125	0.1440

Bufo bufo larval stage

	Estimate	SE	P-value
Intercept	0.36	0.382	0.3456
Wetland area	-2.66	1.195	0.0259

The results showed a positive effect of the augmentation of freshwater proportion on sites and of the augmentation of water surface on the occupancy probability of *Bufo bufo* all stages (table 11). The probability of occupancy is almost at a maximum when the proportion of freshwater on the site exceeds 20% (figure 6.a) and when the surface of water exceeds 5 hectares (figure 6.b)

For the larval stage, I found is a negative effect of wetland area on the occupancy porbability (table 11). The occupancy probability decreases with the augmentation of wetland area on sites and drops to 0 when the site includes more than 20 hectares of wetland (figure 7).

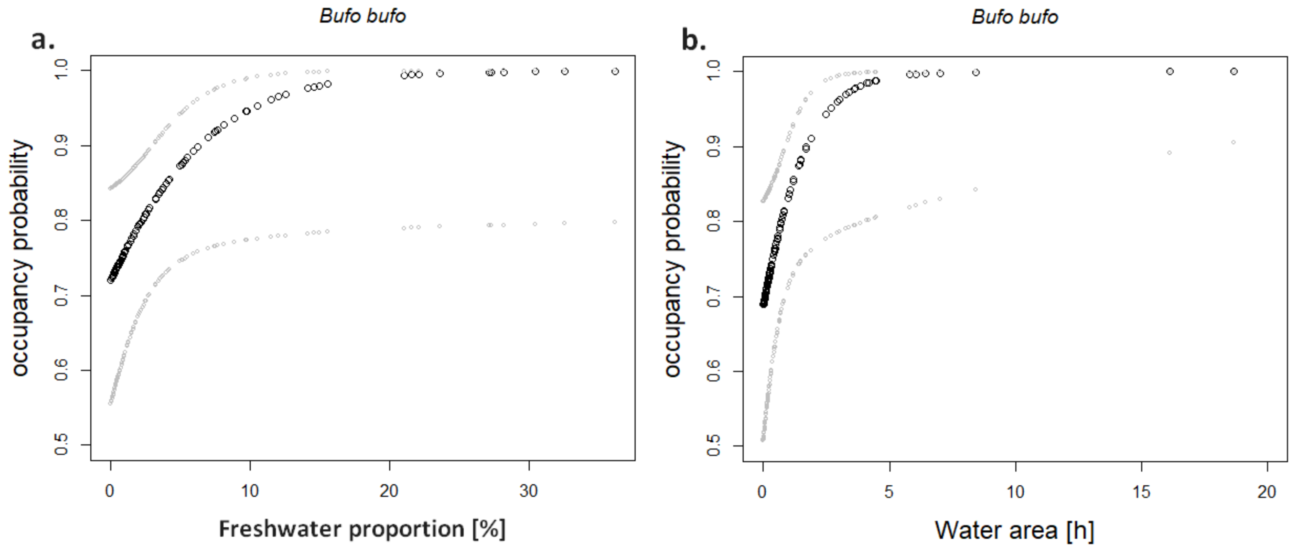

Figure 6: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Bufo bufo* all stages. The graph a represents the relationship between the proportion of freshwater [%] within a site and the occupancy probability. The graph b represents the relationship between the surface of water area within a site (in hectare) and the occupancy probability. The relationship is based on the AICc-best model in table 10. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

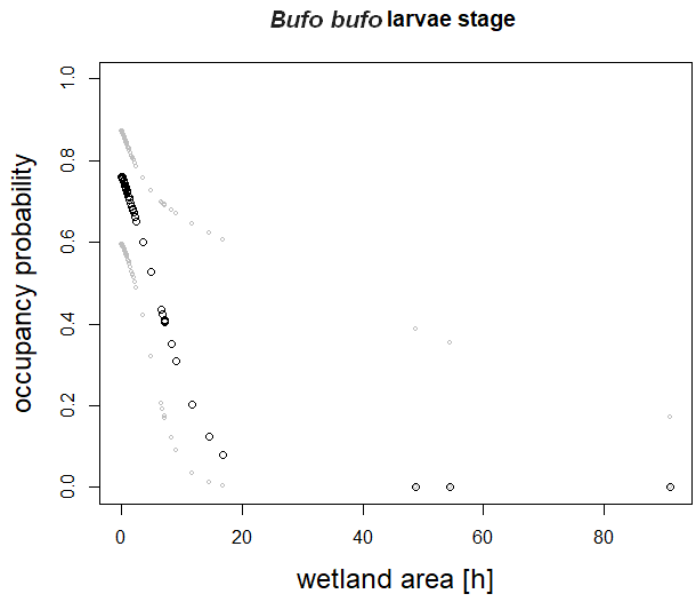

Figure 7: The relationship between the surface of wetland area within a site (in hectare) and the occupancy probability. The relationship is based on the AICc-best model in table 10. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

EPIDALEA CALAMITA

The model selection results for *Epidalea calamita* are shown in table 12.

Table 12: Model selection results of the occupancy analysis for *Epidalea calamita* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Temporary ponds + forest.prop + ruderal.prop)p(.)	5	-44.38	99.3	0	0.999
Larval stage					
Ψ(past.pop)p(.)	3	-21.5	53	0	0.414
Ψ(.)p(.)	2	-24.71	55.13	2.136	0.142
Ψ(Freshwater.prop)p(.)	3	-22.77	55.54	2.539	0.116

The best model for occupancy probabilitiy of detection/non detection of *Epidalea calamita* all stages is: Ψ(*Temporary ponds +* forest.prop)p(.).The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.999) (table 12). In this model, the variables temporary ponds and ruderal proportion have a p-value < 0.05 and are therefore significant (table 13).

For the larval stage, the best model is the one with no environmental variable. The second one contains no covariate. The Akaike weight for the best model represents almost half of the total weight but the p-value is very high (table 13) and is therefore not significant.

Table 13: Parameter estimates of the explanatory variables in the AICc-best model for *Epidalea calamita*. SE is the standard error.

Epidalea calamita adult stage.

	Estimate	SE	P-value
Intercept	-3.6388	0.9721	0.000182
Temporary ponds	0.1809	0.0675	0.007383
Forest proportion	-0.0306	0.0205	0.135710
Ruderal proportion	0.0855	0.0263	0.001164

Epidalea calamita larval stage

	Estimate	SE	P-value
Intercept	5.17	25.1	0.837
Past population	-5.29	21.6	0.807

The results showed a positive effect of the number of temporary ponds on the occupancy of *Epidalea calamita* all stages (table 13). As shown in figure 8.a, the occupancy probability increases with the augmentation of the number of temporary ponds on the sites. Regarding the proportion of forest on sites, there is a negative effect on the occupancy probability (table 13). The occupancy probability decreases with the augmentation of the proportion of forest on sites and drops to 0 when the site contains more than 90% of forest (figure 8.b). As shown in figure 8.c, the occupancy probability increase with the augmentation of the proportion of ruderal surface within site.

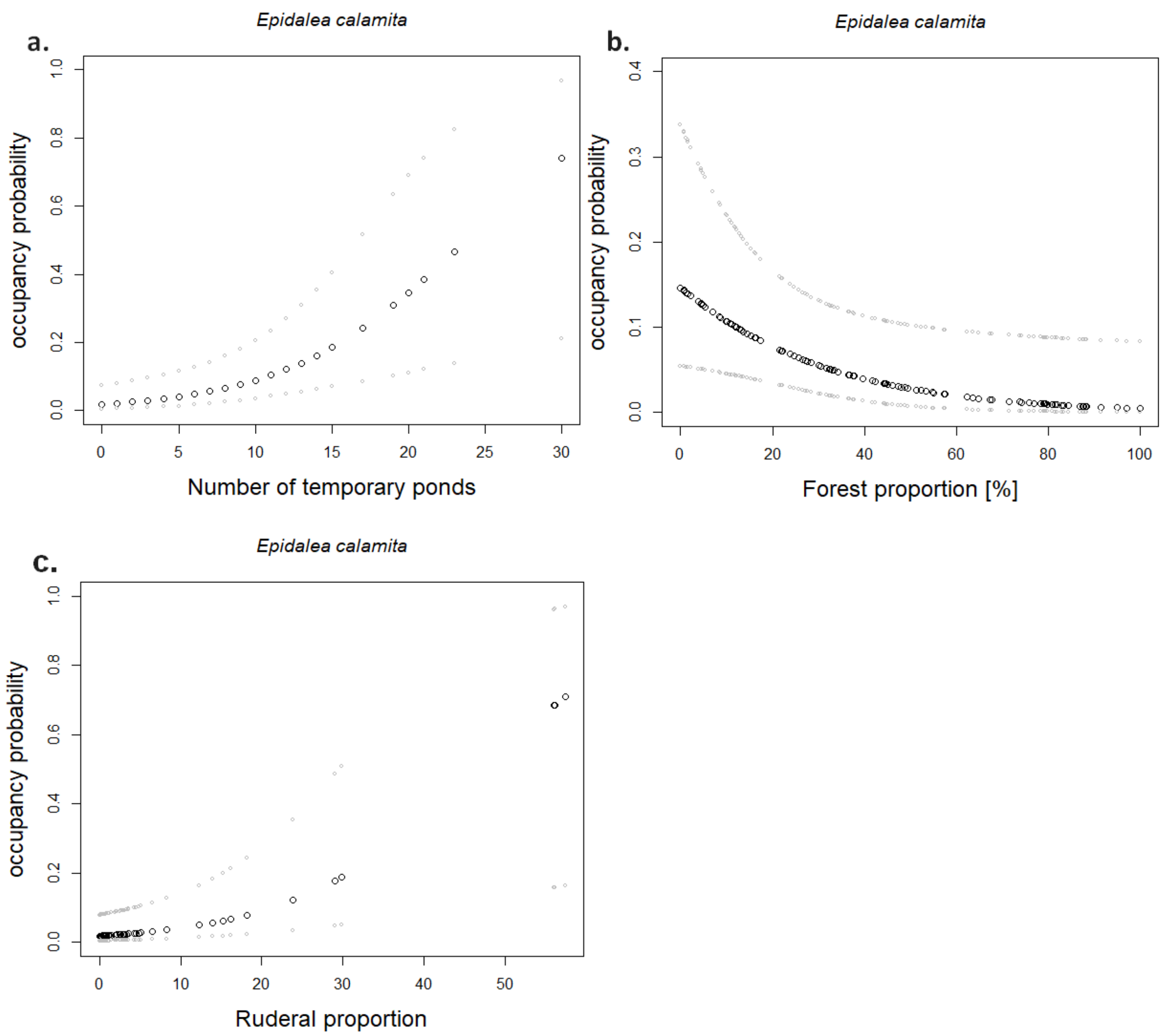

Figure 8: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Epidalea calamita* all stages. The graph a represents the relationship between the number of temporary ponds within a site and the occupancy probability. The graph b represents he relationship between the forest proportion [%] within a site and the occupancy probability. The graph c represents the relationship between the proportion of the rudeal surface within site and the occupancy probability. The relationship is based on the AICc-best model in table 12. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

HYLA ARBOREA

The model selection results for *Hyla arborea* are shown in table 14.

Table 14: Model selection results of the occupancy analysis for *Hyla arborea* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Wetland.prop + past.pop + Freshwater.prop + Freshwater.prop^2)p(.)	5	-126.15	262.84	0	0.252
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-126.42	263.38	0.534	0.193
Larval stage					
Ψ(field.prop)p(.)	3	-21.25	49.59	0	0.278
Ψ(wetland.prop)p(.)	3	-22.1	51.29	1.698	0.119

The best model for occupancy probability of detection/non detection of *Hyla arborea* all stages is: Ψ(Wetland.prop + past.pop + connect)p(.).The Akaike weight for the best model is 1.3 times (0.252/0.193) more likely that the second ranked model and the 3 best models represent almost half of the total Akaike weight. The variable wetland proportion of the first model has a p-value < 0,05 and is significant (table 15). For the second ranked model, the variable freshwater proportion is also significant.

For the larval stage, the first model for occupancy probability is: Ψ(field.prop)p(.). The Akaike weight for the best model is 1.4 times (0.278/0.193) more likely that the second ranked model and the two best models represent almost half of the total Akaike weight. The variable field proportion has a p-value > 0.05 and is therefore not significant.

Table 15: Parameter estimates of the explanatory variables in the AICc-best model for *Hyla arborea*. SE is the standard error.

Hyla arborea all stages

	Estimate	SE	P-value
Intercept	-2.13	0.433	0.000000902
Wetland proportion	0.042	0.024	0.079
Past population	1.272	0.511	0.013
Freshwater proportion	0.160	0.127	0.208
Freshwater proportion ^2	-0.009	0.006	0.115

Hyla arborea larval stage.

	Estimate	SE	P-value
Intercept	-1.43	0.806	0.0767
Field proportion	1.66	0.894	0.0632

The results showed a positive effect of the proportion of wetland within the sites on the occupancy of *Hyla arborea* all stages (table 15). As shown in figure 9.a, the occupancy probability increase with the augmentation of the proportion of wetland on the sites. Concerning the proportion of freshwater on sites, there is also a positive effect on the occupancy probability (table 15). The occupancy probability increase with the augmentation of the proportion of freshwater within the sites and reaches to 1 when the site comprises more than 25% of freshwater (figure 9.b).

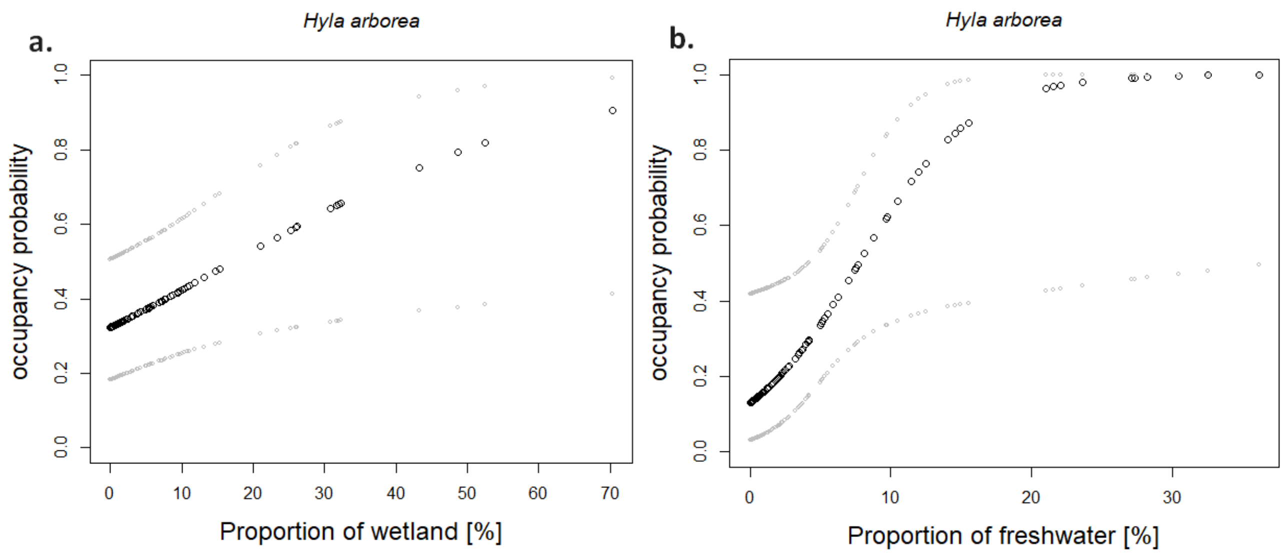

Figure 9: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Hyla arborea* all stages. The graph a represents the relationship between the wetland proportion [%] within a site and the occupancy probability. The graph b represents the relationship between the Freshwater proportion [%] within a site and the occupancy probability. The relationship is based on the AICc-best model in table 14. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

HYLA INTERMEDIA

The model selection results for *Hyla intermedia* are shown in table 16.

Table 16: Model selection results of the occupancy analysis for *Hyla intermedia* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Altitude + connect + TotalS)p(.)	5	-64.95	142.04	0	0.550
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-64.12	143.35	1.311	0.285

The best model for the occupancy probability of detection/non detection of *Hyla intermedia* all stages is: Ψ(Altitude + past.pop + connect + TotalS)p(.).The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.550) (table 16) and is 2 times more likely that the second ranked one. The environmental variable on this model has a pp-value > 0.05 and is therefore not significant (table 17).

There is not enough data for *Hyla intermedia* larvae to perfom analysis. Larvae were only found at 3 of 118 sites.

Table 17: Parameter estimates of the explanatory variables in the AICc-best model for *Hyla intermedia*. SE is the standard error.

	Estimate	SE	P-value
Intercept	5.31	3.75	0.157
Altitude	-0.0125	0.0093	0.176
Connectivity	-3.40	2.78	0.151
Total surface	0.165	0.185	0.374

ICHTHYOSAURA ALPESTRIS

The model selection results for *Ichthyosaura alpestris* are shown in table 18.

Table 18: Model selection results of the occupancy analysis for *Ichthyosaura alpestris* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Altitude + Number.ponds + fieldarea + I(Number.ponds^2)+ past.pop + connect)p(.)	8	-198.92	417.51	0	0.834
Larval stage					
Ψ(field.prop)p(.)	3	-117.37	241.07	0	0.993

The best model for the occupancy probability of detection/non detection of *Ichthyosaura alpestris* all stages is: Ψ(Altitude + Number.ponds + fieldarea + I(Number.ponds^2)+ past.pop + connect)p(.).The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.834) (table 18). This model contains 4 different environmental variables. Only the altitude variable has a p-value > 0.05 and is consequently significant. However, field area and number of freshwater are very close to a p-value < 0.05 (table 19).

For larval stage, the best model for the occupancy probabilities of detection/non detection is: Ψ(field.prop)p(.).The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.993) (table 18). The only variable contained in the best model has a p-value > 0.05 and is therefore not significant (table 19).

Table 19: Parameter estimates of the explanatory variables in the AICc-best model for *Ichthyosaura alpestris.* SE is the standard error.

Ichthyosaura alpestris all stages

	Estimate	SE	P-value
Intercept	-3.24021	1.06118	0.00226
Past population	3.40607	0.66492	0.000000301
Number of ponds	0.14031	0.08191	0.0866
Altitude	0.00431	0.00189	0.02257
Connectivity	-1.91840	1.30992	0.14305
Field area	-0.08928	0.05262	0.08973
Number of ponds ^2	-0.00279	0.00201	0.16476

Ichtoysaura alpestris larval stage

	Estimate	SE	P-value
Intercept	1.55	1.75	0.376
Field proportion	4.16	3.33	0.211

The results showed a positive effect of Altitude and of the number of freshwater within the sites on the occupancy probability of *Ichthyosaura alpestris* all stages (table 19). As shown in figure 10.a, the occupancy probability increases with the augmentation of the altitude on the sites as well as with the augmentation of number of freshwater bodies (figure 10.b).

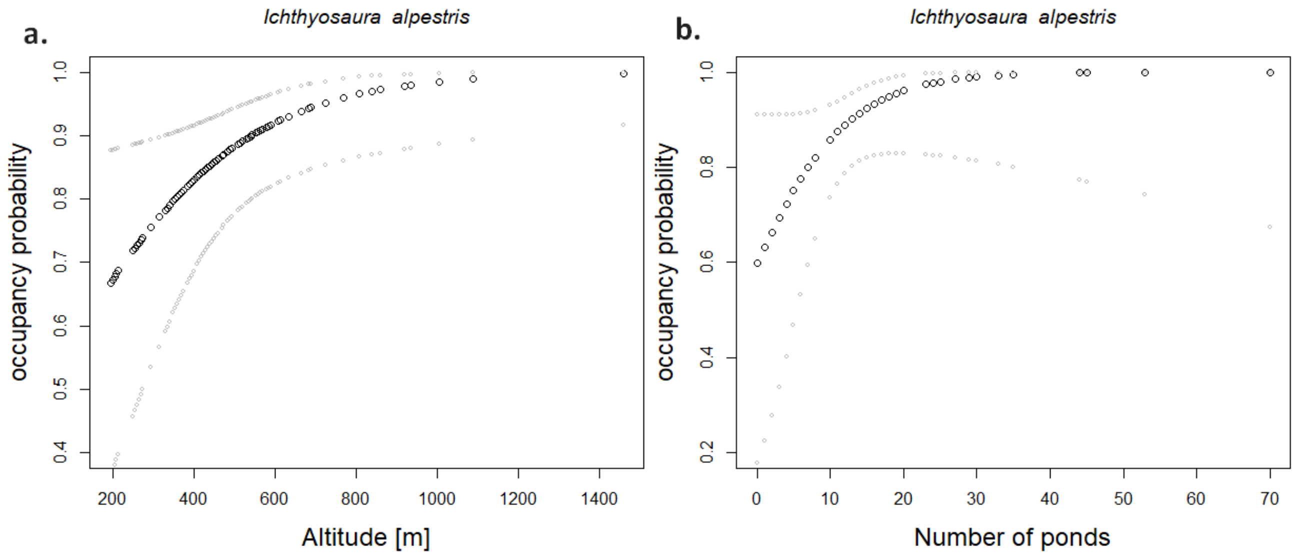

Figure 10: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Ichthyosaura alpestris* all stages. The graph a represents the relationship between the altitude (in meter) within a site and the occupancy probability. The graph b represents the relationship between the number of freshwater within a site and the occupancy probability. The relationship is based on the AICc-best model in table 18. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

LISSOTRITON HELVETICUS

The model selection results for *Lissotriton helveticus* are shown in table 20.

Table 20: Model selection results of the occupancy analysis for *Lissotriton helveticus* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(meadow.prop + past.pop+ connect)p(.)	5	-167.22	344.98	0	0.243
Ψ(forest.prop + past.pop + connect)p(.)	5	-167.82	346.17	1.183	0.134
Larval stage					
Ψ(field.prop)p(.)	3	-43.08	92.67	0	0.723
Ψ(field area + TotalS)p(.)	4	-43.26	95.39	2.716	0.186

The best model for the occupancy probability of detection/non detection of *Lissotriton helveticus* all stages is: Ψ(meadow.prop + past.pop+ connect)p(.). The Akaike weight for the best model is 1.8 times (0.243/0.134) more likely that the second ranked model (table 20) and the 3 best models represent almost half of the total Akaike weight. The variable Meadow proportion has a p-value < 0.05 and is consequently significant (table 21). The forest proportion variable on the second ranked model is also significant.

For larval stage, the best model for the occupancy probability of detection/non detection is: Ψ(field.prop)p(.).The Akaike weight for the best model is 3.8 times (0.723/0.186) more likely that the second ranked model (table 20) and the 2 best models represent almost the maximum of Akaike weight. The only variable contained in the best model has a p-value > 0.05 and is therefore not significant (table 21).

Table 21: Parameter estimates of the explanatory variables in the AICc-best model for *Lissotriton helveticus.* SE is the standard error.

Lissotriton helveticus all stages

	Estimate	SE	P-value
Intercept	-1.7470	0.7390	0.0180
Past population	3.2775	0.5380	0.000000112
Meadow proportion	-0.0261	0.0126	0.0380
connectivity	0.5668	1.1030	0.607

Lissotriton helveticus larval stage.

	Estimate	SE	P-value
Intercept	-2.166	0.757	0.0042
Field proportion	0.471	0.279	0.0907

The results showed a negative effect of the proportion of meadow within the sites on the occupancy probability of *Lissotriton helveticus* all stages (table 21). As shown in figure 11.a, the occupancy probability decreases with the augmentation of the proportion of meadow on the sites. However, there is a small increase in the probability of occupancy when the proportion of forest increase within the sites (figure 11.b).

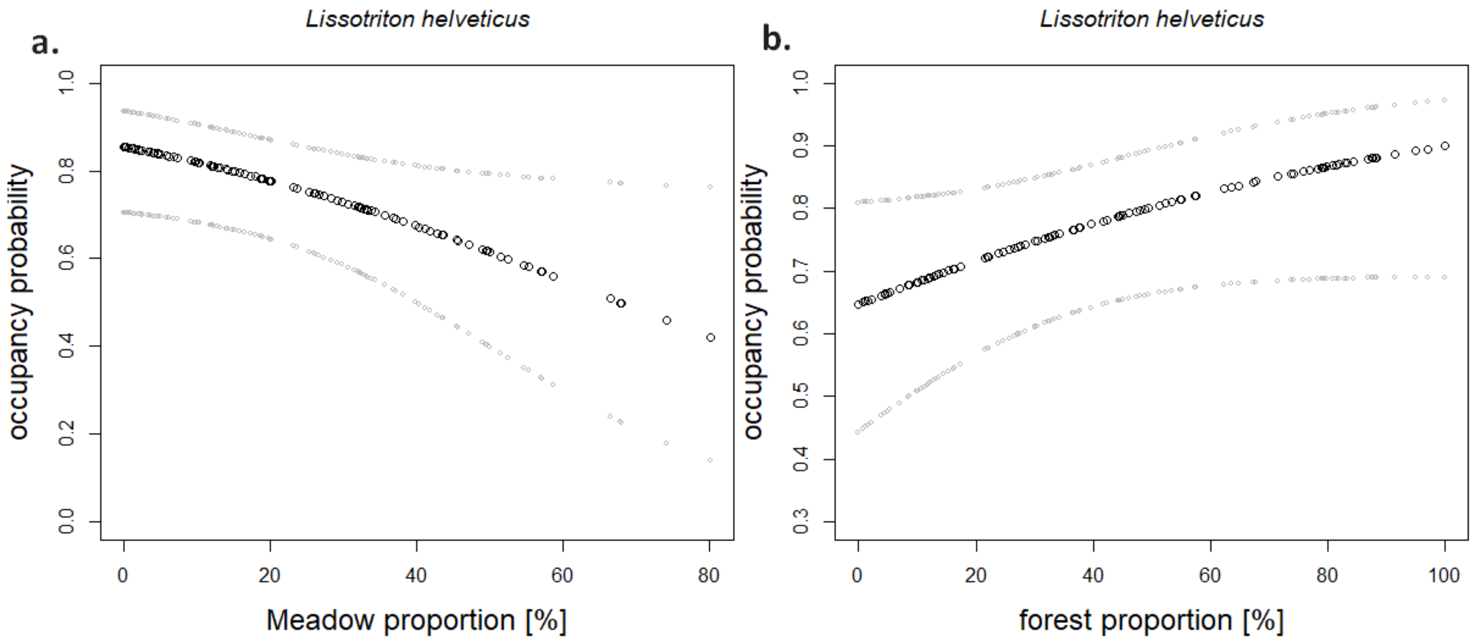

Figure 11: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Lissotriton helveticus* all stages. The graph a represents the relationship between the proportion of meadow [%] within a site and the occupancy probability. The graph b represents the relationship between the proportion of forest [%] within a site and the occupancy probability. The relationship is based on the AICc-best model in table 20. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don’t have data for all cases.

PELOPHYLAX SP

The model selection results for *Pelophylax sp.* are shown in table 22.

Table 22: Model selection results of the occupancy analysis for *Pelophylax sp.* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	W
Adult stage					
Ψ(Num.ponds + Num.ponds^2 + connect)p(.)	5	-277.41	565.36	0	0.691
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-276.22	567.46	2.1	0.242
Larval stage					
Ψ(field.prop)p(.)	4	-86.39	181.27	0	0.410
Ψ(Wetland.a + TotalS)p(.)	3	-87.59	181.48	0.201	0.371

The best model for the occupancy probability of detection/non detection of *Pelophylax sp*. all stages is: Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.).The Akaike weight for the best model represent almost the maximum of the Akaike weight (0.691) (table 22). The variable number of ponds has a p-value < 0.05 and is consequently significant (table 23).

For larval stage, the best model for the occupancy probability of detection/non detection is: Ψ(field.prop)p(.).The Akaike weight for the best model is almost the same that the second ranked model (table 22) and the 2 best model represent almost the total of the Akaike weight. The only variable contained in the best model has a p-value > 0.05 and is therefore not significant (table 22). Also, the standard error of the variable field proportion is high, suggesting that the data may have some notable irregularities.

Table 23: Parameter estimates of the explanatory variables in the AICc-best model for *Pelophylax sp.* SE is the standard error.

Pelophylax sp. all stages

	Estimate	SE	P-value
Intercept	0.158	0.640	0.805
Number ponds	-0.348	0.2098	0.0975
Number ponds^2	0.032	0.0154	0.0371
connectivity	2.135	0.970	0.0278

Pelophylax sp. larval stage.

	Estimate	SE	P-value
Intercept	1.67	2.34	0.476
Field proportion	8.23	5.46	0.132

The results showed a negative effect of the number of freshwater within the sites on the occupancy probability of *Pelophylax sp.* all stages (table 23). As shown in figure 12, the occupancy probability decreases drastically when the number of freshwater is more than 15. However, the the standard error is high.

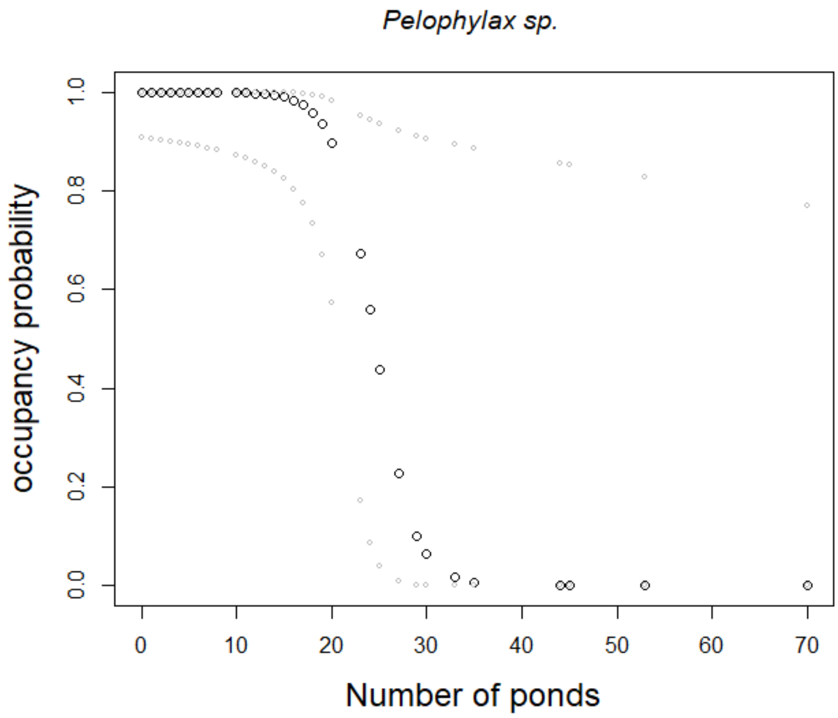

Figure 12: The relationship between the number of freshwater within the sites and the occupancy probability of *Pelophylaxsp.* all stages. The relationship is based on the AICc-best model in table 22. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

RANA DALMATINA

The model selection results for *Rana dalmatina* are shown in table 24.

Table 24: Model selection results of the occupancy analysis for *Rana dalmatina* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
All stages					
Ψ(Freshwater.prop + past.pop + Altitude + field area)p(.)	6	-122.05	256.86	0	0.968
Larval stage					
Ψ(Altitude + Number.ponds)p(.)	4	-72.08	153.53	0	0.531
Ψ(Altitude + TotalS)p(.)	4	-72.31	154	0.464	0.421

The best model for the occupancy probability of detection/non detection of *Rana dalmatina* all stages is: Ψ(Freshwater.prop + past.pop + Altitude + field area)p(.). The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.968) (table 24). This model contains 3 environmental variables. The variable altitude has a p-value > 0.05 and is consequently significant (table 25) and the variables Freshwater proportion and field area have a p-value very close to 0.05.

For larval stage, the best model for the occupancy probability of detection/non detection is: Ψ(Altitude + Num.ponds)p(.).The Akaike weight of the 2 best models represent almost the maximum of the Akaike weight (table 24) and the first ranked model is only 1.2 times more likely than the second one. The variable altitude contained in the best model has a p-value > 0.05 and is therefore not significant (table 25) but it is very close to 0.05.

Table 25: **Parameter estimates of the explanatory variables in the AICc-best model for *Rana dalmatina*.** SE is the standard error.

Rana dalmatina all stages

	Estimate	SE	P-value
Intercept	0.10136	0.9670	0.91651232
Past population	2.91870	0.6214	0.00000265
Freshwater proportion	-0.10203	0.0578	0.07727161
Altitude	-0.00457	0.0020	0.02257946
Field area	0.10521	0.0544	0.05302101

Rana dalmatina larval stage

	Estimate	SE	P-value
Intercept	5.49	3.10	0.0768
Altitude	-11.49	6.38	0.0720
Num.ponds	-0.91	1.24	0.4648

The results showed a negative effect of the proportion of freshwater within sites on the occupancy probability of *Rana dalmatina* all stages. As shown in figure 13.a, the occupancy probability decreases with the augmentation of the proportion of freshwater on sites. There is also a negative effect of the altitude on the occupancy probability. As shown in figure 13.c, the occupancy probability decrease with the augmentation of the altitude within sites. However, in figure 13.b, the field area surface on sites showed a positive effect on occupancy probability of *Rana dalmatina* all stages.

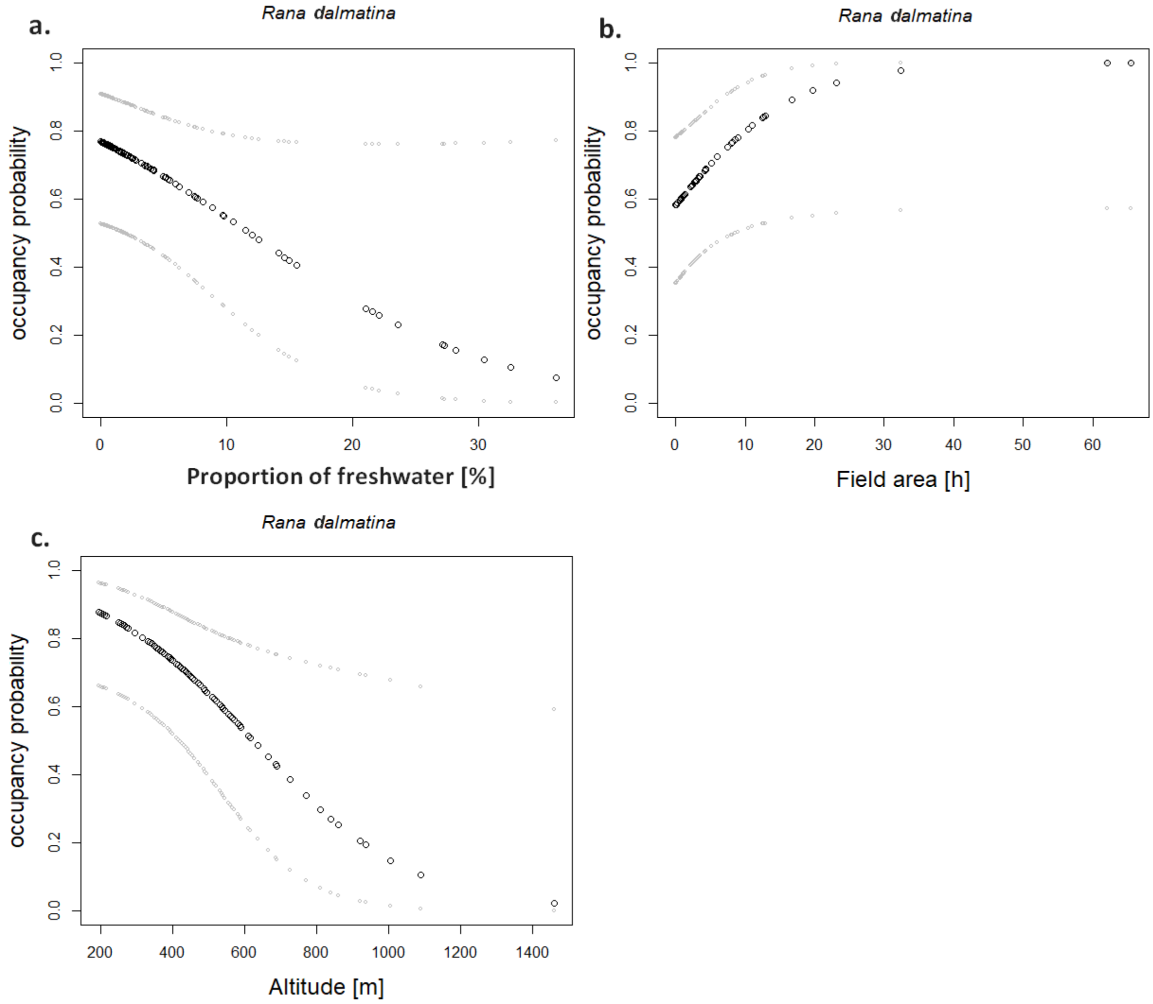

Figure 13: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Rana dalmatina* all stages. The graph a represents the relationship between the proportion of freshwater [%] within a site and the occupancy probability. The graph b represents the relationship between the surface of field area [h] within a site and the occupancy probability. The graph c represents the relationship between the altitude [m] and the occupancy probability. The relationship is based on the AICc-best model in table 24. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

TRITURUS CARNIFEX

The model selection results for *Triturus carnifex* are shown in table 26.

Table 26: Model selection results of the occupancy analysis for *Triturus carnifex* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
Adult stage					
Ψ(forest area)p(.)	3	-58.98	124.75	0	0.834

The best model for the occupancy probability of detection/non detection of *Triturus carnifex* all stages is: Ψ(forest area)p(.). The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.834) (table 26). This model contains only one variable which has a p-value < 0.05 and is consequently significant (table 27).

There is not enough data for *Triturus carnifex* larvae to perform analysis. Larvae were only found at 4 of 118 sites.

Table 27: **Parameter estimates of the explanatory variables in the AICc-best model for *Triturus carnifex*.** SE is the standard error.

	Estimate	SE	P-value
Intercept	-1.213	0.6023	0.0440
Forest area	0.135	0.0682	0.0481

The results showed a positive effect of the augmentation of forest area within the sites on the occupancy probability of *Triturus carnifex* all stages (table 27). As shown in figure 14, the occupancy probability increases when the surface of Forest increases on the sites.

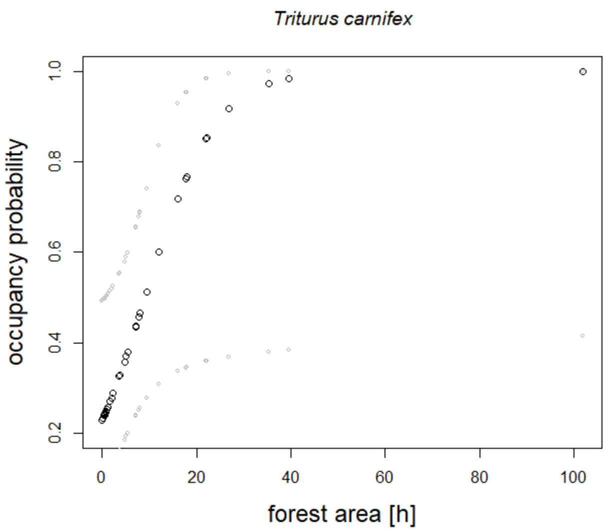

Figure 14: The relationship between the surface of forest awithin a site (in hectare) and the occupancy probability of *Triturus carnifex* all stages. The relationship is based on the AICc-best model in table 26. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

LISSOTRITON VULGARIS

The model selection results for *Lissotriton vulgaris* are shown in table 28.

Table 28: Model selection results of the occupancy analysis for *Lissotriton vulgaris* for the two analyses (all life history stages and only larvae). The meaning of the symbols is explained in table 4.

Models	K	logLik	AICc	ΔAICc	w
Adult stage					
Ψ(Number.ponds+ Freshwater.prop + freshwater.prop^2 + Lands.a + past.pop)p(.)	7	-98.87	212.75	0	0.997
Larval stage					
Ψ(.)p(.)	2	-31.15	66.92	0	0.164
Ψ(lands.prop)p(.)	3	-30.25	67.84	0.917	0.104

The best model for the occupancy probability of detection/non detection of *Lissotriton vulgaris* all stages is: Ψ(Num.ponds + Freshwater.prop + Still.waterprop^2 + Lands.a + past.pop)p(.). The Akaike weight for the best model represents almost the maximum of the Akaike weight (0.997) (table 28). All variables of this model present a p-value < 0.05 and are consequently significant (table 29).

For the larval stage, the best model is the one with no covariates. The Akaike weight is not very high for the first model and is distributed among all the models, suggesting that there is substantial model selection uncertainty.

Table 29: Parameter estimates of the explanatory variables in the AICc-best model for *Lissotriton vulgaris*. SE is the standard error.

	Estimate	SE	P-value
Intercept	-2.6537	0.62207	0.0000199
Past population	1.4940	0.63715	0.0190395
Proportion of freshwater	0.3381	0.14400	0.0188697
Proportion of freshwater^2	-0.0159	0.00683	0.0201034
Lands area	-1.5264	0.60504	0.0116397
Number ponds	0.0953	0.03630	0.0086782

The results showed a positive effect of the proportion of freshwater within the sites on the occupancy probability of *Lissotriton vulgaris* all stages (table 29). As shown in figure 15.a, the occupancy probability increases with the augmentation of the proportion of freshwater on the sites. There is also a positive effect of the number of freshwater within the sites on the occupancy probability (table 29). The occupancy probability increases with the augmentation of freshwater within the sites (figure 15.b). However, there is a negative effect of lands area within sites on the occupancy probability (table 29). The occupancy probability drops to 0 when there are more than 3 hectares of lands on sites (figure 15.c).

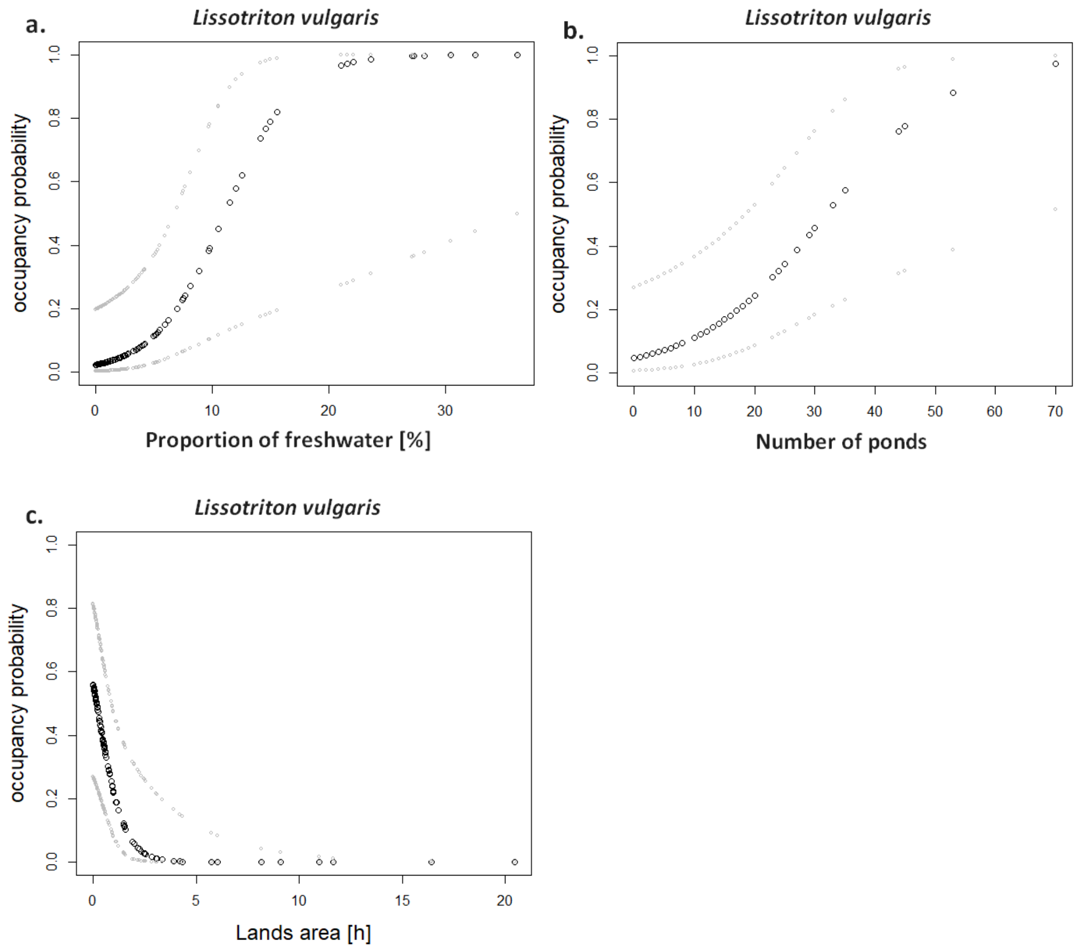

Figure 15: Graphs of the environmental variables of the best model as a function of the probability of occupation in the sites of *Lissotriton vulgaris* all stages. The graph a represents the relationship between the proportion of freshwater [%] within a site and the occupancy probability. The graph b represents the relationship between the Number of freshwater within a site and the occupancy probability. The graph c represents the relationship between the surface of lands [h] and the occupancy probability. The relationship is based on the AICc-best model in table 28. The grey dots represent 95% confidence intervals and the black big dots represents the probability of occupancy. Each black dot is a real datapoint, that is why the spaces between dots are unequal because we don't have data for all cases.

GRAPH WITH MULTIPLE SPECIES

In order to compare the effects of the different variables according to the species, a series of graphs grouping several species were produced. Only graphs of the variables found in the best model of multiple species were made. For a better reading of the graphs, confidence intervals have not been added.

The variable proportion of freshwater is the environmental variable most present in the best model of all species. There is a positive effect of the proportion of Freshwater for 4 of the 5 species presenting this variable in their best model (figure 16). *Rana temporaria* and *Bufo bufo* present a similar curve and their occupancy probability is at is maximum when there are more than 10% of freshwater within sites. *Hyla intermedia* and *Lissotriton vulgaris* also have a similar curve. The probability of occupancy begins to rise sharply when there is more than 5% water in the site and is at its highest when there is more than 20% water within sites. However, *Rana dalmatina* shows a decrease in is probability of occupancy when the proportion of freshwater increases.

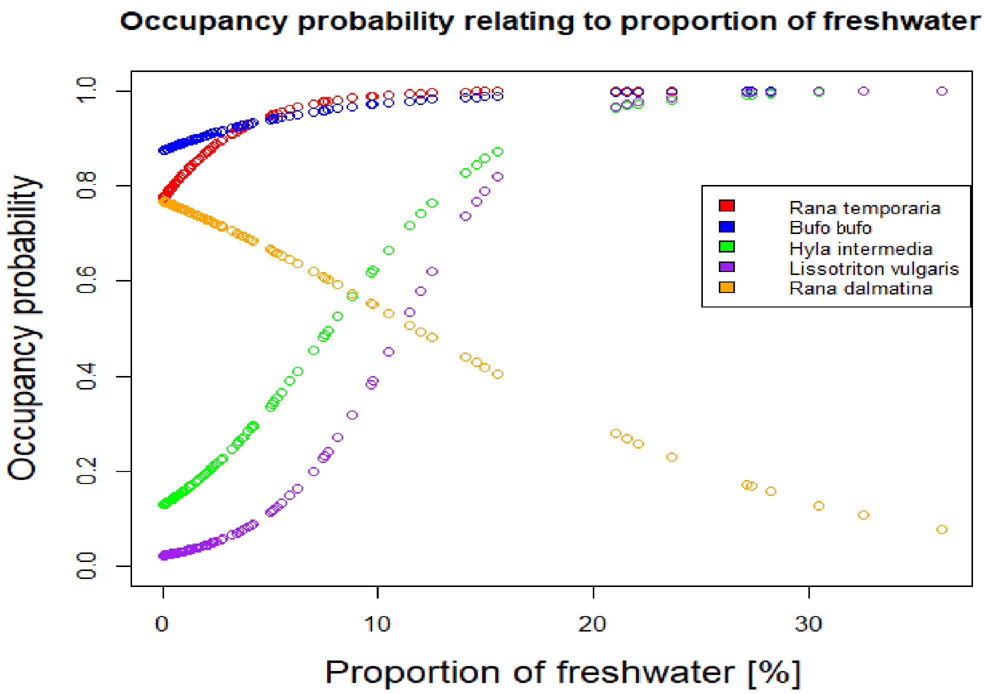

Figure 16: Graph of the occupancy probability relating to proportion of freshwater of *Rana tempoaria, Bufo bufo, Hyla intermedia, Lissotriton vulgaris* and *Rana dalmatina*. The relationship is based on the AICc-best model.

Two species present the variable number of temporary ponds in their best model (figure 17). Increasing the number of temporary ponds has a positive effect on the probability of occupancy of both species. *Epidalea calamita* needs more temporary ponds than *Bombina variegata* but their probability of occupancy is highest when there are more than 30 temporary ponds on the site and would continue to increase if the data went beyond 30.

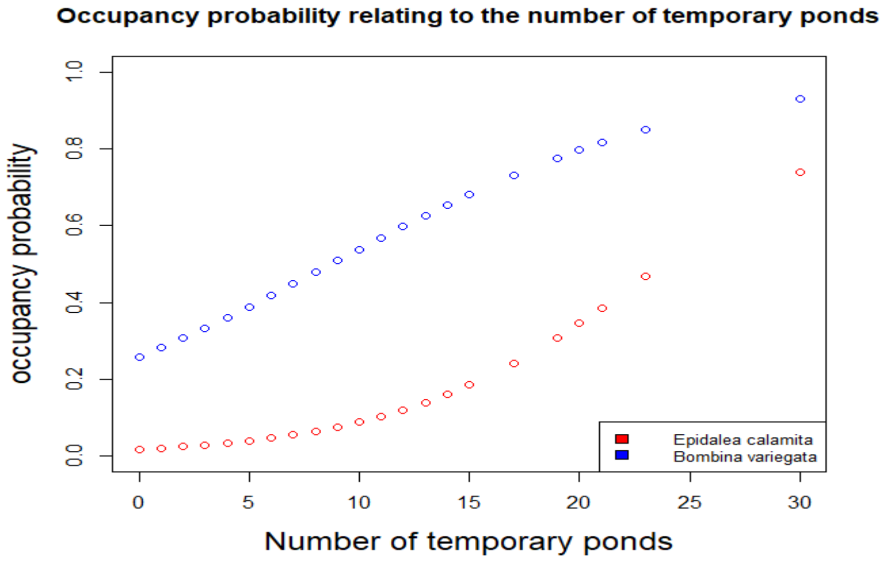

Figure 17: Graph of the occupancy probability relating to the number of temporary ponds of *Epidalea calamita* and *Bombina variegata*. The relationship is based on the AICc-best model.

Three species have the variable number of ponds in their best model (figure 18). There is a positive effect of this variable on the occupancy probability for 2 of the 3 species. *Lissotriton vulgaris* need more freshwater than *Ichthyosaura alpestris.* For *Pelophylax sp.*, the occupancy probability decreases drastically when the number of ponds is higher than 15.

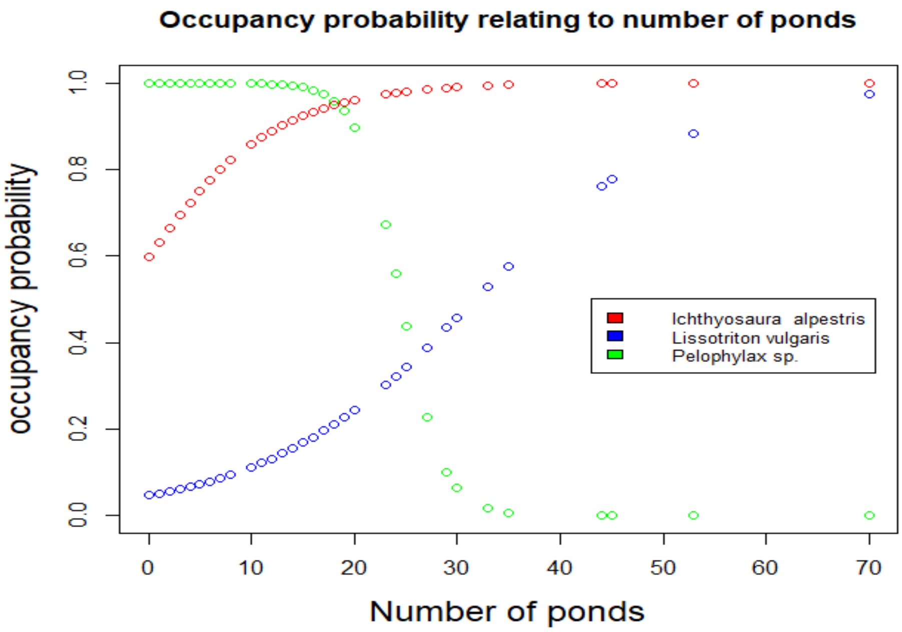

Figure 18: Graph of the occupancy probability relating to the number of ponds within sites of Ichthyosaura alpestris, Lissotriton vulgaris and Pelophylax sp. The relationship is based on the AICc-best model.

Two species have the variable forest proportion in their best model (graph 19). There is a slight increase in the probability of occupancy for *Lissotriton helveticus* when the proportion of forest within sites increases, in contrast to *Epidalea calamita* where the probability decreases.

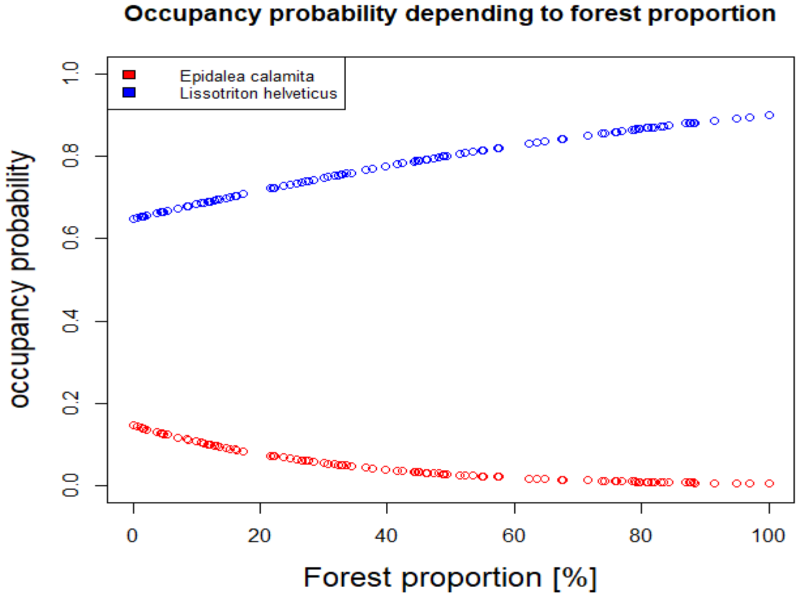

Figure 19: Graph of the occupancy probability relating to the proportion of forest within sites of *Epidalea calamita* and *Lissotriton helveticus*. The relationship is based on the AICc-best model. The colors represent the different species and are explained in the small box inside the graph.

Three species have the variable field area in their best model (figure 20). There is a similar effect of the augmentation of field area within sites on the occupancy probability of *Bombina variegata* and *Ichthyosaura alpestris*. Their occupancy probability decreases with the augmentation of field area. This is the opposite for *Rana dalmatina*, its occupancy probability increases with the increase of fields in the sites.

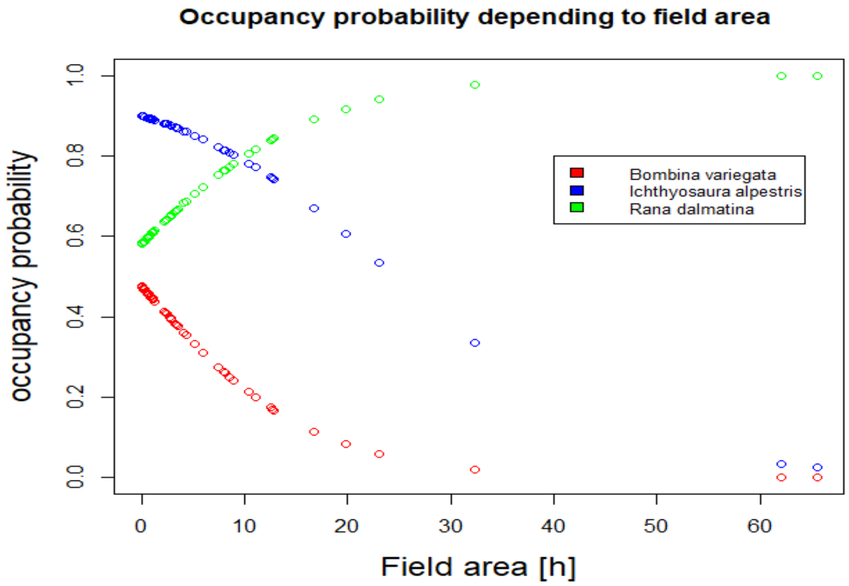

Figure 20: Graph of the occupancy probability relating to the field surface within sites of *Bombina variegata, Ichthyosaura alpestis* and *Rana dalmatina*. The relationship is based on the AICc-best model.

Three species have the variable altitude in their best model (figure 21). *Rana temporaria* and *Ichthyosaura alpestris* show a similar curve. The augmentation of altitude within sites increase their occupancy probability while it decreases the probability of occupation of *Rana dalmatina*.

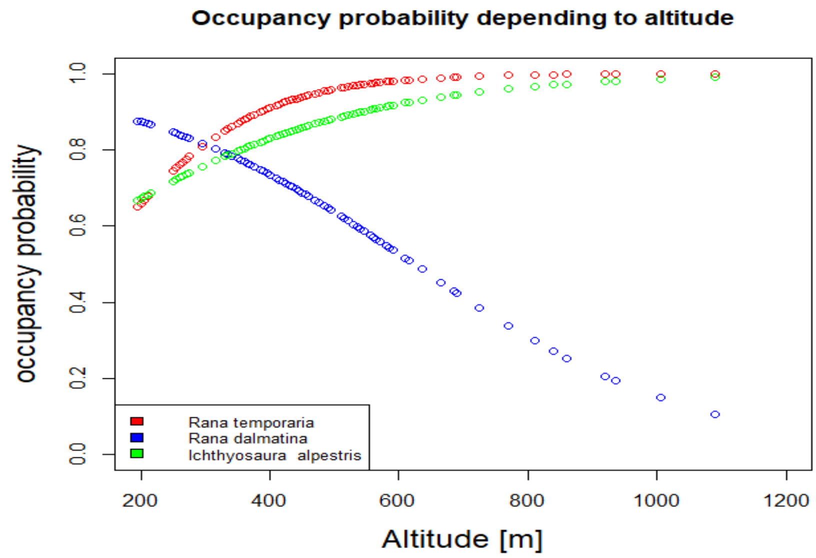

Figure 21: Graph of the occupancy probability relating to the atitude within sites of *Rana temporria, Rana dalmatina* and *Ichthyosaura alpestris*. The relationship is based on the AICc-best model.

Three species have the variable ruderal proportion in their best model (figure 22). There is a similar effect of the augmentation of the proportion of ruderal area within sites on the occupancy probability of *Bombina variegata* and *Epidalea calamita*. Their occupancy probability increases with the augmentation of proportion of ruderal area. There is no visible effect of this variable on the probability of occupancy of *Alytes obstetricans*.

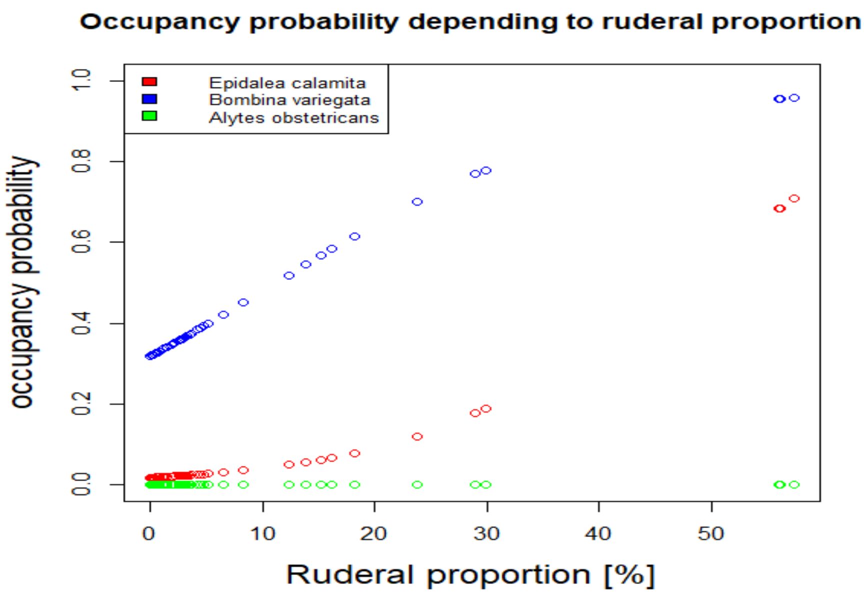

Figure 22: Graph of the occupancy probability relating to the proportion of rudeal area within sites of *Epidalea calamita, Bombina variegata* and *Alytes obstetricans*. The relationship is based on the AICc-best model.

SUMMARY TABLE

A summary table of the results is presented below.

Table 30: **summary of the environmental variables important for each species and their effect.** Only the variables present in the best model (according to AICc) of each species are present.The symbol "+"means that the variable has a positive effect on the probability of occupancy of the species. The symbol "-"means that the variable has a negative effect on the probability of occupancy of the species. Symbols in brackets mean that these variables are not significant (p-value > 0.05). The abbreviations of the environmental variables are explained in Table 2.
ALOB = *Alytes obstetricans*, RATE = *Rana temporaria*, BOVA = *Bombina variegata*, BUBU = *Bufo bufo*, EPCA = *Epidalea calamita*, HYAR = *Hyla arborea*, HYIN = *Hyla intermedia*, ICAL = *Ichthyosaura alpestris*, LIHE = *Lissotriton helveticus*, PESP= *Pelophylax sp*., RADA = *Rana dalmatina*, TRCA = *Triturus carnifex*, LIVU= *Lissotriton vulgaris.*

Explenatory variables	ALOB	RATE	BOVA	BUBU	EPCA	HYAR	HYIN	ICAL	LIHE	PESP	RADA	TRCA	LIVU
Past.pop	+	(+)	+	+		+		+	+		+		+
Connect	(+)	(+)					(-)	(-)	(+)	+			
TotalS			+				(+)						
Altitude		+					(-)	+			-		
Water.a				(+)									
Num.ponds								(+)		-			+
Num.temporary ponds			+		+								
Freshwater.a													
Freshwater.prop		+		(+)		(+)					(-)		+
Build.a													
Build.prop													
Wetland.a													
Wetland.prop	(-)					(+)							
Meadow.a													
Meadow.prop									-				
Lands.a													-
Lands.prop													
Forest.a												+	
Forest.prop					(-)								
Field.a			(-)					(-)			+		
Field.prop													
Ruderal.a													
Ruderal.prop	+		+		+								

5. Discussion

Pond characteristics were the best predictors of the occurrence of multiple amphibian species in nature reserves. The results can be used to improve the management of the nature reserves in such a way that the persistence of the amphibian species can be increased.

However, it is important to note that the best model for explaining the probability of occupancy was different for each species. This shows that each species has particular needs concerning its environment and that conservation projects must take into account the specific needs of the target species. Similar results can be found in other studies. For example, a study on four newt species showed that the response to habitat characteristics differs among each species and that they are notable ecological differences among them (Denoël et al. 2008).

5.1 ENVIRONMENTAL VARIABLE RELATED TO THE AQUATIC ENVIRONMENT

Variables describing the aquatic habitat were frequently included in the best models of the analysis. This can be explained by the fact that the aquatic habitat is vital for the reproduction of amphibian populations. The destruction of the aquatic habitat is even considered as the principal cause of the worldwide decline in amphibians (Ficetola et al. 2015). Variables describing the aquatic habitat were included in the best occupancy models for 9 out of 13 species. These variables generally had a positive effect on the probability of occupancy of amphibian species, except for two species where they show a negative effect (*Rana dalmatina* and *Pelophylax sp*.).

The variable proportion of freshwater was present in the best model of five species. *Rana temporaria* and *Bufo bufo* showed a high probability of occupancy, even when there is a low proportion of ponds. These two species are common and present in a large number of sites, but the probability of occupancy is at its maximum when the site has a proportion of ponds of at least of 10%. This suggests that even for these common and widespread species, an increase in the percentage of water in the site has a strong effect on their probability of occupancy. *Hyla arborea* and *Lissotriton vulgaris* showed a similar effect in their probability of occupancy relating to the proportion of freshwater. Occupancy is very low when the site contains only a small percentage of water, but there is a strong increase when there is more than 10% of freshwater. This suggests that for conservation purpose, is necessary to maximize the freshwater surface in IBN sites in order to favour these 4 species.

For *Rana dalmatina*, the results showed a slight decrease in the probability of occupation of the species when the proportion of freshwater increases within the sites. However, the p-value of this variable his 0.078, which is not significant but not far from it. This result should therefore be interpreted with caution. On the other hand, a study show that small water bodies strictly related to agricultural activities can be attractive breeding sites for *Rana dalmatina* (Biaggini et al. 2018), which would be consistent with the results obtained. Indeed, the results also show that increasing the field area in the sites would have a positive effect on the occupancy probability of this species.

Concerning the number of ponds within sites, I found that this variable is present in the best model of 3 species. This variable includes temporary and permanent bodies of water. For *Ichthyosaura alpestris* and *Lissotriton vulgaris*, there is a positive effect of the augmentation of the number of ponds within the sites. *Ichthyosaura alpestris* is a common species and can be present even when there are a small number of ponds, but its probability of occupancy sees a strong increase when the amount of water points increases in the site. *Lissotriton vulgaris* needs large amount of ponds in sites and its occupancy probability constantly increases as the number of ponds growth. These results showed the importance of the construction and managment of more ponds in IBN sites. The construction of additional ponds is a common management measure to improve functional connectivity in amphibians and the new ponds can be quickly colonized (Le Lay et al., 2015).

For *Pelophylax sp*., it would appear that there is a negative effect of increasing numbers of ponds on the site. However, the results were not significant and the graph had a rather high confidence interval, meaning that the results should be interpreted with caution. Moreover, the green frog complex is the most problematic amphibian in Western Europe and causes a lot of ecological damage (Dufresnes et al. 2018). This species can threaten the indigenous frog (*Pelophylax lessonae*) through competition for resources, predation and by hybridization (Vorburger et al. 2003). In order to improve this analysis, only native species should be taken into account. However, they are difficult to differentiate and genomic analyses would therefore be necessary.

Another variable concerning the aquatic environment is the number of temporary ponds. They are habitats of critical importance for many amphibian species (Griffiths, 1997). The results showed that it is important for two of the studied species. Indeed, we can see a constant augmentation of the probability of occupancy for *Bombina variegata* and *Epidalea calamita* when the number of temporary ponds increases within sites. In other words, a large number of temporary ponds is needed to favour these two species. The average number of temporary ponds in amphibian breeding sites of national importance studied in this study is 5, while the average number of temporary ponds in sites where *Epidalea calamita* has been detected is 12 and 9 for sites where *Bombina variegata* was detected. This suggest that in order to make the sites more attractive to these two species, the creation of additional temporary ponds would be necessary.

These results showed that it is essential to give special attention to water bodies when building or restoring areas suitable for amphibians. The increase in pond surface as well as in the number of ponds generally has a positive effect on most of the species studied. In order to improve conservation effort, it is necessary to see whether the number of ponds as well as the total surface area of ponds is sufficient in IBN sites.

5.2 ENVIRONMENTAL VARIABLE RELATED TO THE TERRESTRIAL HABITAT

Concerning terrestrial habitats, there are no variables that are particularly recurrent in the best models. However, we can notice that at least one variable describing terrestrial habitats is included in the best models for 11 of the 13 species studied. The terrestrial habitat variables most represented are fields, forest, ruderal and wetland area. Terrestrial variables are expected to influence the distribution of newts because they require suitable terrestrial habitat for the post-breeding season, and it should be close to the ponds because they do not migrate large distance (Griffiths, 1996). In the results, I found that two species of newts (*Lissotriton helveticus* and *Triturus carnifex*) depends on forests, and that their augmentation within sites has a positive effect on the probability of occupation of these species. This is consistent with other studies that found that *Lissotriton helveticus* is strongly dependant on forest presence and that the distance between forest and breeding site is important (M. Denoël et al., 2008). Also, presence of forest near ponds can affect the substrate with leaf litter or dead wood and can have a positive effect on newt populations (Marty et al., 2005). However, the proportion of forest shows a negative effect for *Epidalea calamita*. This is not surprising, since this is a pioneer species that likes terrestrial habitats with open surfaces on filter substrates such as gravel pit and sand (Böll et al., 2011). This is why the majority of the population in Switzerland is located in gravel pits, sand pits, landfills or even construction sites.

Concerning the explanatory variable field areas, the results showed a negative effect on the probability of occupancy of *Bombina variegata* and *Ichthyosaura alpestris*. For the two species, the probability of occupancy highly decreases with the augmentation of field area within sites. Although we cannot know exactly why these fields have a negative effect on these two species, numerous studies demonstrate the harmful effects of chemicals used in the fields for amphibian populations (Boone et al., 2002) and by the diminution and fragmentation of the terrestrial habitat causing by agricultural expansion. But as said previously, the presence of fields has a positive effect for *Rana dalmatina* occupancy probability. Although agricultural land shows many negative aspects, some studies have shown that in some agricultural areas, constructed agricultural ponds can represent an important breeding habitat for amphibians if properly managed (Knutson et al., 2004).

Another variable presents on the best model of two species is the proportion of wetland within sites. It shows a strong negative effect for *Alytes obstetricans* but there is a positive effect for *Hyla arborea*, whose probability of occupancy increases with the augmentation of wetland within the sites. It means that these two species do not have the same needs and we cannot have an IBN site that is good for both.

The variable ruderal proportion was present on the best model of three species (*Alytes obstetricans, Bombina variegata and Epidalea calamita*). There is a positive effect of this variable on the probability of occupancy of these species. However, there was only a slight effect for *Alytes obstetricans* and therefore this variable should not be considered as a priority for this species. For *Epidalea calamita*, increasing the proportion of ruderal area in the sites has a strong positive effect on its probability of occupancy. This is consistent with another study that demonstrates that *Epidalea calamita* shows a preference for bare environments (Stevens et al., 2006). There is also a strong positive effect of this variable on the probability of occupancy of *Bombina variegata*. Another study shows that *Bombina variegata* and *Epidalea calamita* exhibited significant affinity for pools with high levels of ground disturbance (Warren & büttner, 2010).

Finally, the variable meadow proportion is present in the best model of Lissotriton helveticus and had a negative effect. Indeed, the probability of occupancy decreases with the augmentation of meadow area within site, but the species can still be found on the site even If there is a high proportion of meadow. It is therefore not a particularly important variable to consider in conservation projects.

Terrestrial habitats are therefore important for amphibians, they must be taken into account during conservation project. For example, previous study shows the importance of forest around breeding site for amphibian population (Porej et al., 2004). Although urban areas are not represented in the best models, many studies show the negative effect of roads near egg-laying sites. Indeed, they are particularly dangerous at the time of migration for many species.

5.3 OTHERS VARIABLES: PAST POPULATION, CONNECTIVITY, TOTAL SURFACE AND ALTITUDE

In accordance with my basic hypothesis, the explanatory variables past population are found in almost all models and always has a positive effect on the probability of species occupancy. This suggests that the probability of encountering a species at a site is greater if that species was already present in the past and that the overall suitability of the sites has not changed.

Connectivity is slightly less important and is found in 6 of the top 13 models. This variable has a positive effect on occupancy of 4 species (*Alytes obstetricans, Rana temporaria, Lissotriton helveticus* and *Pelophylax sp.*). This shows that connectivity is still an important variable to explain the occupancy of a species in a site, but it appeared to be less important than expected. Indeed, another recent study on amphibian populations in Switzerland showed that the connectivity of breeding sites with adjacent populations was an important determinant of the occupancy of the species breeding in the ponds studied (Cruickshank et al., 2020).

Contrary to the basic hypothesis, the total surface area of the object had no influence on the probability of species occupancy. Indeed, the total surface area variable was present in the best model of only one species. It is therefore more important to pay attention to the management of the site rather than its size. Howerver, all environmental variables are positively correlated with the total area of the site. This showed that there is still a relationship between the total area and the area of these environmental variables. It seems logical that the increase of the total area leads to an increase in the surface of the different environmental variables. However, as mentinonned earlier, it is not enough to simply create large protected area. It is also important to ensure that these area contains adequate features, such as temporary ponds or forests area.

Finally, the altitude variable was present in the best model of 4 species, but is significant for only 3 of them. *Rana temporaria* and *Ichthyosaura alpestris* prefered sites with high altitudes, but are still present at low altitudes. Contrary to *Rana dalmatina* which is more likely to be present in low altitude sites and see its probability of occupancy decreases greatly with increasing altitude. This result showed that amphibian population can be sensitive to the effects of altitude. This may be due to the fact that topography and climate vary with altitude (Giordano et al., 2007).

5.4 LARVAL STAGE

Analyses of the larval stage did not give many results and do not allow us to determine in which habitats the species are more likely to reproduce. Only the analysis of *Bufo bufo* larvae gave significant results and showed a decrease in the number of larvae as a function of wetland area. Therefore, I cannot propose any better amenagment of IBN sites that would improve the presence of larvae. In order to have results for larvae analysis, it may be necessary to focus on others water variables such as water pollution or the presence of predators. Inded, the survival of larvae depends on food supply, competition and predation, temperature and the risk of desiccation of the ponds (Griffiths, 1997).

5.5 FURTHER RESEARCH

In order to improve this study and conservation projects, more research should be conducted. Indeed, several variables that we have not studied here could be interesting and important for the development of new protected areas for amphibians. For example, the presence of fish in breeding ponds is an important variable affecting the amphibian populations. Generally, there is a negative effect of the presence of fish. They are predators of amphibian and can also consume invertebrate and disturb pond ecosystems (Schabetsberger et al., 2006). Also, water depth seems to affect the distribution of all newt species (Denoël et al. 2008) as well as the size of ponds.

The type of vegetation of the water points as well as the substrate could also be interesting variables to analyse. Moreover, this study focused on the detection/non-detection of the species, but an analysis of the abundance could reinforce the results. An abundance analysis was done but it did not work. It may be necessary to analyse a larger number of sites in order to obtain results.

5.6 CONSERVATION IMPLICATIONS

The results suggested that for effective conservation projects, it is very important to consider the needs of each species. Also, variables related to the aquatic environment are very important for the majority of species. An augmentation of the proportion of freshwater in the site is beneficial for several species. Special attention should also be paid to the number of ponds. The increase of number of ponds have a large positive effect and it is also important to consider temporary ponds in environments conducive to *Epidalea calamita* and *Bombina variegata.*

The terrestrial habitat should also not be neglected. Aquatic and terrestrial habitat are required in IBN sites. Indeed, the results suggest that breeding sites near fields should be avoided. For newts, proximity to the forest is important. The presence of wetlands should be avoided for *Alytes obstetricans* while they should be favoured for *Hyla arborea*. Also, the presence of ruderal area is important for *Epidalea calamita* and *Bombina variegata*. Several studies have shown the importance of the habitat complementation. The term "landscape complementation" was coined by Dunning et al. (1992) to highlight the need to link different types of habitats together in order to complete the life cycle of certain species, such as amphibians. It is therefore important to take these different habitats into account for conservation projects. A study show that successful amphibian conservation action depends on landscape complementation and that ponds created near suitable terrestrial microhabitats were more successful in attracting and maintaining *Alytes obstetricans* populations (Schmidt et al., 2019).

In addition, management for amphibian breeding should pay attention to maintain connectivity between sites. Indeed, in the Swiss lowlands, urbanisation, intensive agriculture and a dense traffic infrastructure cause a large habitat fragmentation (Jaeger et al., 2008). Moreover, a study using genetic analyses has found that the conservation and connectivity measures taken for the tree frog in the Reuss valley have been successful (Angelone & Holderegger, 2009).

It is also important to take account the common species. Generally, conservation projects give priority to endangered and rare species, but some works highlight the importance of common species in the ecosystem, because they may have a disproportionate impact on vital ecosystem structures and functions due to their overall biomass (Gaston et al., 2008). For example, the common toad (*Bufo bufo*) is very widespread in the analysed sites and was detected in 90 of the 118 sites. However, a study show that toad populations are greatly declining and could decreased by 30% in 10 years (Petrovan et al., 2016). That is why this species is now considered as vulnerable under IUCN Red List and that it should thus not be neglected.

Finally, it is important to take into account the difficulties and limitations of the development of IBN sites. Setting up new sites and developing or maintaining existing sites takes time and money. It is important to take these elements into account. It is more difficult and time-consuming to develop terrestrial habitats rather than aquatic habitats. Therefore, priority should be given to the construction and maintenance of ponds and to consider longer term development of terrestrial habitats. For example, increasing the number of temporary ponds in existing sites could be a good start to the application of measures to improve IBN sites.

6. Conclusion

Despite the important role of amphibians in ecosystem functions and their drastic decline in recent decades, amphibians are not always taken into account in conservation programs and are among the least studied taxonomic groups in and around urban areas (Pickett et al.., 2001, McDonnell and Hahs, in press). They are also good indicators of ecosystem change because they are sensitive to aquatic and terrestrial changes as well as to UV radiation and water quality (Gerlanc and Kaufman 2005, Taylor et al. 2005). For this reason, it is important to raise public awareness of the importance of these animals and to continue to create suitable areas for their survival.

In conclusion, this work has made it possible to highlight the environmental variables that are important for species-rich amphibian breeding sites. As water is essential for their reproduction, it is not surprising that water has proven to be very important in explaining the presence of species in these nationally important breeding sites. However, the results highlighted the importance of the open water surface in the sites as well as the number of permanent and temporary water points. It is also important to take into account the specific needs of each species, as these were found to be more or less different for each. However, it is difficult to control terrestrial habitats such as the percentage of forest in the site. It is then necessary to focus on possible developments, such as the construction of more water points.

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9. Annexes

Annex 1: Habitat typology based on natural habitats in Switzerland from Delarze et al. 2015.

Service conseil IBN – Biotopes d'importance nationale
Soutien technique sur mandat de l'Office fédéral de l'environnement OFEV
Inventaire des sites de reproduction de batraciens d'importance nationale

Annexe 1: Typologie des habitats à cartographier (Delarze et al. 2015).

	Grands milieux	Code	Milieux naturels	Par exemple
1.	Eaux libres *Gewässer*		**Eaux calmes** ***Stehende Gewässer***	A numéroter et à lister de manière exhaustive en Annexe 2.
		1.2	**Eaux courantes** ***Fliessgewässer***	Epipotamon, Hyporhitron, Metarhitron, Epirhitron
2.	Rivages et lieux humides *Ufer und Feuchtgebiete*	2.0	**Rivages artificiels** ***Künstliche Ufer***	Enrochements, digues, quais…
		2.1	**Roselières** ***Ufer mit Vegetation***	Phragmition, Phalaridion
		2.2	**Bas marais** ***Flachmoore***	Magnocaricion, Cladietum, Caricion
		2.3	**Prairies humides** ***Feuchtwiesen***	Molinion, Calthion, Filipendulion
		2.4	**Tourbières bombées** ***Hochmoore***	Sphagnion magellanici
3.	Rochers, éboulis, moraines *Fels, Schutt und Geröll*	3.2	**Rochers, éboulis, moraines** ***Alluvionen***	Alluvions avec végétation pionnière y.c. (Epilobion fleisheri)
4.	Pelouses et prairies *Grünland (Naturrasen, Wiesen und Weiden)* *Jeweils mit Angabe zur Nutzung:* *a Wiese (z.B. 4.5a)* *b Weide (z.B. 4.5b)*	4.0	**Gazons et prairies artificiels** **Kunstrasen**	Prairies temporaires, gazons artificiels Kunstwiese, Kunstrasen auf Sportplätzen usw.
		4.2	**Pelouses sèches thermophiles** ***Wärmeliebende Trockenrasen***	Xerobromion, Mesobromion, Seslerion, Nardion, …
		4.3	**Pelouses et pâturages maigres d'altitude** ***Gebirgs-Magerrasen (ab ca. 1000müM)***	Seslerion, Caricion ferrugineae, etc.
		4.5	**Prairies grasses** ***Fettwiesen und -weiden***	Arrhenatherion, Polygono-Trisetion, Cynosurion, Poion alpinae
5.	Landes et mégaphorbiaies *Hochstaudenfluren und Gebüsche*	5.1	**Lisières herbacées, ourlets** **Krautsäume**	Geranion sanguinei, Trifolion medii, Convolvuluion sepium, Petasition officinalis, Aegopodion + Alliarion
		5.2	**Mégaphorbiaies, coupes forestières** ***Hochstauden- und Schlagfluren***	Epilobion angustifolii, Adenostylion, formations à Pteridium aquilinum
		5.3	**Formations buissonnantes** ***Gebüsche***	Pruno-Rubion, Sambuco-Salicion, Salicion elaeagni Salicion cinereae, Alnenion viridis
		5.4	**Landes** ***Zwergstrauchheiden***	Calluno-Genistion, Juniperion sabinae, Ericion, Juniperion nanae, Rhododendro-Vaccinion
6.	Forêts *Wälder*	6.0	**Plantations** ***Forstpflanzungen***	Dans le cas des plantations d'essences non en station, ajouter une atteinte en superposition
		6.1	**Forêts inondables** ***Bruch- und Auenwälder***	Alnion glutinosae, Salicion albae, Alnion incanae, Fraxinion (nappe phréatique visible ou très proche de la surface, forêts jamais dominées par le hêtre)
		6.2	**Hêtraies** ***Buchenwälder***	Galio-Fagenion et autres hêtraies mésophiles (forêts dominées par le hêtre)
		6.3	**Autres forêts de feuillus** ***Andere Laubwälder***	Acerion, Tilion, Carpinion, Quercion
		6.4	**Pinèdes thermophiles** ***Wärmeliebende Föhrenwälder***	Pinion
		6.5	**Forêts de tourbières** ***Hochmoorwälder***	Betulion pubescentis, Ledo-Pinion, Sphagno-Piceetum
		6.6	**Forêts de cônifères d'altitude** ***Gebirgs-Nadelwälder***	Abieti-Piceion, Vaccinio-Piceion, Larici-Pinetum cembrae, etc.
7.	Végétation pionnière des endroits perturbés par l'homme Pioniervegetation gestörter Plätze (Ruderalstandorte)	7.1	**Terrains piétinés et rudéraux** ***Trittrasen und Ruderalfluren***	Agropyro-Rumicion, Polygonion avicularis, Dauco-Melilotion, Rumicion alpini
		7.2	**Milieux rocheux anthropogènes** ***Anthropogene Steinfluren***	Murs, ruines
8.	Plantations, champs et cultures *Pflanzungen, Äcker, Kulturen*	8.1	**Cultures de plantes ligneuses** ***Baumschulen, Obstgärten, Rebberge***	
		8.2	**Cultures de plantes herbacée** ***Feldkulturen (Äcker)***	
9.	Milieux construits *Bauten, Anlagen*	9.0	**Milieux construits** ***Bauten, Anlagen***	Décharges, bâtiment, voies de communication, terrain de sport revêtu, place de parc *Lagerplätze, Bauten, Verkehrswege, Versiegelter Sportplatz, Parkplatz, usw.*

Appendix 2: Description of water bodies based on the average level during the breeding season (April to July).

Service conseil IBN – Biotopes d'importance nationale
Soutien technique sur mandat de l'Office fédéral de l'environnement OFEV
Inventaire des sites de reproduction de batraciens d'importance nationale

Annexe 2: Description des habitats larvaires

Objet: | **Auteur:** | **Date de visite:**

ID2	Typologie	Prof. Max	Prof. Médiane	Ensoleillement	Qualité de l'eau	Végétation			Fluctuation du niveau d'eau	Substrat du fond	Poissons	Remarques/espèces observées
						Pourcentage (à 10%) de couverture du plan d'eau						
Reporter sur carte!	*Cf. typologie ci-dessous*	*Profondeur maximale (m)*	*Profondeur médiane (m)*	*Pourcentage (à 10%) d'ensoleillement à la verticale du plan d'eau entre mai et juin*	*oligo- méso (OM) eu-hypertr. (EH)*	[illegible]	[illegible]	[illegible]	*inconnue (IN) nulle ou faible (NF) moyenne (MO) peut s'assécher (AS)*	*sables, graviers (SG) bâche, béton (BB) feuilles, tourbe (FT) vase, argile (VA)*	*observés (1) pas observés (0)*	*Autres éléments pertinents relatifs au plan d'eau*
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												

La description des plans d'eau se base sur le niveau moyen en période de reproduction (avril à juillet).

Typologie	Français	Allemand
RL	Lac (> 1 km2), rives de lac	See (> 1 km2)
ET	Etang (> 1'000 m2)	Weiher (> 1'000 m2)
MA	Petit plan d'eau, mare permanente stagnante (< 1'000 m2)	Kleinweiher permanent (< 1'000 m2)
MC	Petit plan d'eau, mare permanente avec écoulement	Kleinweiher permanent, mit Durchfluss
GO	Gouille temporaire	Tümpel, Kolk, Schlenke (temporär)
PR	Flaque	Pfütze, Wasserlache, Vernässungfläche
OR	Ornière	Spurrinne, Radspur
FO	Fossé d'évacuation des eaux	(Entwässerungs-)Graben
BS	Bassin à fonction technique (incendie, rétention, décantation, amortisseur…)	Feuerlöschteich, Speicherbecken, Absetzbecken, Klärbecken, Rückhaltebecken, Baggersee
RU	Ruisseau	Bach
CA	Rivière, canal	Fluss
O-M	<30% du volume d'eau avec algues filamenteuses et autres organismes indicateurs de nutriments en excès	
E-H	>30% du volume d'eau avec algues filamenteuses et autres organismes indicateurs de nutriments en excès	

Appréciation générale de l'objet (en particulier en regard des espèces cibles – sp EN ou taille de pop. =4):

Propositions de mesures de revitalisation priorisées (1= urgent, 2= à moyen terme, 3=nice to have)

Annex 3: Typology of damage.

Service conseil IBN – Biotopes d'importance nationale
Soutien technique sur mandat de l'Office fédéral de l'environnement OFEV
Inventaire des sites de reproduction de batraciens d'importance nationale

Annexe 3: Liste des atteintes

	Historische Elemente	Eléments historiques
101	**Gefährdung historischer Elemente**	**Menace sur des éléments historiques**
99	Keine Spezifizierung, andere	Non spécifié, autre
	Bauten	Constructions
103	**Wohn- und Ökonomiegebäude**	**Bâtiments résidentiels et utilitaires**
1	Wohnhaus	Habitation
2	Industrie oder militärisches Gebäude	Bâtiment industriel ou militaire
3	Land-, alpwirtschaft- oder forstlisches Gebäude	Bâtiment agricole ou alpestre ou forestier
99	Keine Spezifizierung, andere	Non spécifié, autre
104	**Spezialbauten und -Anlagen**	**Constructions et installations particulières**
1	Kläranlage	Station d'épuration des eaux usées
2	Antennen und Leitungen	Antennes et lignes aériennes
3	Rohrleitungen und Bodenkabel	Conduites et câbles souterrains
4	Trink- und Brauchwasserfassungen	Captages d'eau potable
5	Wasserkraftanlagen	Installations hydroélectriques
6	Offene Wasserleitungen	Conduites d'eau à ciel ouvert
7	Militärisches Gelände mit Anlagen	Terrains et installations militaires
8	Lawinenverbauung	Pare-avalanches
99	Keine Spezifizierung, andere	Non spécifié, autre
111	**Wasserbau**	**Aménagement des cours d'eau**
1	Stauwehr	Barrage
2	Eindämmung	Endiguement
3	Uferverbauung, Hartverbau (inkl. Buhnen)	Stabilisation des berges en dur (y.c. épis)
4	Uferverbauung, ingenieurbiologisch	Stabilisation des berges, génie biologique
5	Sohlenbefestigung (inkl. Schwellen) fischgängig	Stabilisation du lit (y.c. seuil, radier) franchissable
6	Sohlenbefestigung (inkl. Schwellen, rückhaltedamm)	Stabilisation du lit (y.c. seuil, radier, retenue) non franchissable
99	Keine Spezifizierung, andere	Non spécifié, autre
112	**Verkehrsinfrastrukturen**	**Infrastructures de transport**
1	Kunstbauten und Hangeinschnitte	Ouvrages d'art et remblais
2	Strassen	Routes
3	Separate Wege für Langsamverkehr	Chemins à trafic lent
4	Park- und Abstellplätze	Places de parc et de dépôt
5	Flugplätze	Aérodromes
6	Eisenbahnanlagen	Installations ferroviaires
7	Seilbahnanlagen und Schlepplifte	Téléphériques et remontées mécaniques
99	Keine Spezifizierung, andere	Non spécifié, autre
122	**Landwirtschaftliche Anlagen**	**Installations agricoles**
1	Bewässerungs- oder Sprinkleranlage	Installation d'irrigation ou d'arrosage
99	Keine Spezifizierung, andere	Non spécifié, autre
123	**Sport- und Freizeitanlagen (ohne Bahnen)**	**Infrastruct. de sports et loisirs (ss remontées)**
1	Bootshäfen und Anlegestellen	Ports et places d'amarrages
2	Campingplatz	Camping
3	Offizieller Picknickplatz und Feuerstelle	Place de pique-nique ou de grillade aménagée
4	Piste alpin	Piste de ski alpin
5	Beschneiungsanlagen	Installations pour canons à neige
6	Langlaufpiste	Piste de ski de fond
7	Joggingpiste	Piste de jogging
8	Golfplatz	Terrain de golf
99	Keine Spezifizierung, andere	Non spécifié, autre
	Bodenveränderung	Modification du sol
127	**Reliefveränd. und Zerstörung von Strukturen**	**Modif. du relief et destruction de structures**
99	Keine Spezifizierung, andere	Non spécifié, autre
128	**Abbau von Boden, Kies und Stein**	**Extraction de matériaux**
99	Keine Spezifizierung, andere	Non spécifié, autre
129	**Deponien und Schüttungen**	**Dépôts et décharges**
1	Natürliches Lockermaterial	Matériau minéral
2	Erde, Humus, Pflanzen	Terre, humus, végétal
99	Keine Spezifizierung, andere	Non spécifié, autre

130	**Bodenverletzungen**	**Dégradations du sol**
1	Abfall	Déchets
2	Fahrspuren	Traces de véhicules
3	Mensch- oder Viehspuren	Traces pédestres ou de bétail
4	Baustellen	Chantiers
99	Keine Spezifizierung, andere	Non spécifié, autre
132	**Landwirtschaftlicher Betrieb**	**Activités agricoles**
1	Ackerbau	Grandes cultures
2	Düngung	Engraissement
3	Beweidung	Pâture
4	Überweidung	Sur-pâturage
5	Nutzungsänderungen in der Landwirtschaft	Changements d'exploitation agricole
6	Nutzungsaufgabe	Abandon de l'exploitation
99	Keine Spezifizierung, andere	Non spécifié, autre
133	**Drainagen**	**Drainages**
1	Unsachgemässer Grabenunterhalt	Entretien inapproprié de fossé
2	Offener Graben	Fossé à ciel ouvert
3	Rohre	Tuyau
4	Schacht	Regard
5	Flächige Drainage	Drainage de surface
6	zum Schutz von Strassen	Drainage des routes
7	forstliche Drainage	Drainage forestier
99	Keine Spezifizierung, andere	Non spécifié, autre
	Schädliche Aktivitäten	Activités dommageables
135	**Forstlischer Betrieb**	**Activités sylvicoles**
1	Holzschlag	Coupe
2	Pflanzung	Plantation
3	Unsachgemässe Pflege	Entretiens inadéquats
99	Keine Spezifizierung, andere	Non spécifié, autre
142	**Aktivitäten an Gewässern**	**Activités de lacs et cours d'eau**
1	Störung Abfluss	Perturbation du débit
2	Störung Geschiebe	Perturbation du charriage
3	Wasserspielschwankung	Fluctuation du niveau d'eau
4	Schiffbarkeit	Navigation
5	Fischbesatz	Rempoissonnement
6	Zuschüttung	Comblement, remblayage
7	Stabilisierung, Verbauung, Steinschüttung	Empierrement
8	Verlandung	Atterrissement
99	Keine Spezifizierung, andere	Non spécifié, autre
148	**Freizeitaktivitäten**	**Activités de loisirs**
99	Keine Spezifizierung, andere	Non spécifié, autre
151	**Fehlende oder unzureichende Pufferzonen**	**Zones-tampon manquantes ou insuffisantes**
99	Keine Spezifizierung, andere	Non spécifié, autre
	Naturereignisse	Phénomènes naturels
156	**Erosion und Naturereignisse**	**Erosion et phénomènes naturels**
1	Torferosion	Erosion de la tourbe
2	Grossflächige (Ufer-)Erosion durch Fluss	Erosion massive par une rivière
3	Sohlenabsenkung	Incision du lit
4	Erdrutsche oder Lawinen	Glissement de terrain ou avalanche
99	Keine Spezifizierung, andere	Non spécifié, autre
158	**Invasive Arten**	**Espèces invasives**
99	Keine Spezifizierung, andere	Non spécifié, autre
159	**Verbrachung**	**Embroussaillements**
1	Verbuschung und Verwaldung	Embroussaillement ou progression naturelle de la forêt
2	Vergrasung	Enherbement
3	Adlerfarn	Ptéridium, fougère impériale
99	Keine Spezifizierung, andere	Non spécifié, autre
	Anderes	Autres
160	**Anderes**	**Autres**
99	Keine Spezifizierung, andere	Non spécifié, autre

Annex 4: Complete model selection results of the occupancy analysis for all stages and larval stage for all species. Ranking and weighting is according to AICc. K is the number of parameters in the model, logLik is the log-likelihood of the model, AICc is the small-sample Akaike information criterion. ΔAICc is the difference between a model and the model with the lowest AICc value. w is the Akaike weight.

***Alytes obstetricans* all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(wetland.prop + ruderal.prop +past.pop + connect)p(.)	6	-56.14	125.03	0	0.720
Ψ(wetland.prop + past.pop + connect)p(.)	5	-58.44	127.41	2.383	0.219
Ψ(Wetland.a + TotalS + past.pop + connect)p(.)	6	-58.61	129.97	4.943	0.061
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-62.55	140.12	15.09	0
Ψ(ruderal.prop +past.pop + connect)p(.)	6	-64.34	141.44	16.41	0
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-66.02	144.79	19.76	0
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-66.49	145.73	20.697	0
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-67.68	145.9	20.867	0
Ψ(Number temporary ponds + past.pop + connect + TotalS)p(.)	6	-67.75	148.26	23.226	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-69.06	148.65	23.615	0
Ψ(field.prop + past.pop + connect)p(.)	5	-69.15	148.83	23.801	0
Ψ(connect + past.pop + TotalS)p(.)	5	-69.15	148.83	23.803	0
Ψ(Forest.a+ TotalS + past.pop + connect)p(.)	6	-68.07	148.9	23.871	0
Ψ(build.prop + past.pop + connect)p(.)	5	-69.2	148.93	23.902	0
Ψ(area.water + past.pop + connect + TotalS)p(.)	6	-68.09	148.94	23.907	0
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-68.09	148.94	23.909	0
Ψ(ruderal.a+ TotalS + past.pop + connect)p(.)	6	-68.15	149.06	24.028	0
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-68.27	149.29	24.261	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-69.39	149.32	24.289	0
Ψ(lands.prop + past.pop + connect)p(.)	5	-69.59	149.71	24.679	0
Ψ(lands.prop + past.pop + connect)p(.)	6	-68.48	149.71	24.683	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-68.59	149.94	24.913	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-69.11	150.98	25.95	0
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-69.13	151.02	25.991	0
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-68.06	151.15	26.115	0
Ψ(.)p(.)	2	-76.27	156.64	31.61	0

Alytes obstetricans larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(.)p(.)	2	-35.88	76.76	0	0.174
Ψ(field.prop)p(.)	3	-34.46	77.1	0.336	0.147
Ψ(lands.prop)p(.)	3	-35.12	78.43	1.666	0.076
Ψ(buil.prop)p(.)	3	-35.22	78.63	1.869	0.068
Ψ(wetland.prop)p(.)	3	-35.37	78.93	2.166	0.059
Ψ(connect)p(.)	3	-35.41	79	2.245	0.057
Ψ(TotalS)p(.)	3	-35.45	79.09	2.328	0.054
Ψ(meadow.a + TotalS)p(.)	4	-33.55	79.1	2.337	0.054
Ψ(past.pop)p(.)	3	-35.79	79.77	3.006	0.039
Ψ(Freshwater.prop)p(.)	3	-35.8	79.78	3.023	0.038
Ψ(Temporary ponds)p(.)	3	-35.87	79.92	3.16	0.036
Ψ(forest.prop)p(.)	3	-35.88	79.94	3.178	0.035
Ψ(field area + TotalS)p(.)	4	-34.08	80.17	3.409	0.032
Ψ(meadow.prop)p(.)	3	-36.31	80.81	4.048	0.023
Ψ(Lands.a + TotalS)p(.)	4	-34.84	81.69	4.927	0.015
Ψ(Num.ponds + TotalS)p(.)	4	-34.87	81.74	4.976	0.014
Ψ(Wetland.a + TotalS)p(.)	4	-34.88	81.75	4.991	0.014
Ψ(Altitude + TotalS)p(.)	4	-35	82	5.237	0.013
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-35.11	82.22	5.461	0.011
Ψ(Build.a + TotalS)p(.)	4	-35.15	82.3	5.538	0.011
Ψ(Freshwater.a + TotalS)p(.)	4	-35.28	82.55	5.793	0.01
Ψ(Water.a + TotalS)p(.)	4	-35.3	82.6	5.836	0.009
Ψ(Forest.a+ TotalS)p(.)	4	-35.39	82.79	6.029	0.009
Ψ(Num.ponds + Num.ponds ^2 + TotalS)p(.)	5	-34.86	86.39	9.627	0.001
Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)	5	-34.89	86.44	9.68	0.001

Rana temporaria all stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ (connect + past.pop + Freshwater.prop + Altitude) p(.)	6	-268.11	548.97	0	0.935
Ψ (Freshwater.prop + connect + past.pop)p(.)	5	-272.88	556.29	7.32	0.024
Ψ (Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-271.06	557.14	8.173	0.016
Ψ (Freshwater.prop + Freshwater.prop^2 + past.pop + connect)p(.)	6	-272.32	557.39	8.423	0.014
Ψ (Altitude + past.pop + connect + TotalS)p(.)	6	-272.65	558.07	9.093	0.01
Ψ (Freshwater.a + past.pop + connect + TotalS)p(.)	6	-275.26	563.28	14.309	0.001
Ψ (Num.ponds + past.pop + connect + TotalS)p(.)	6	-276.53	565.82	16.851	0
Ψ(Temporary ponds + past.pop + connectivity + TotalS)p(.)	6	-277.82	568.4	19.424	0
Ψ (Build.prop + past.pop + connect)p(.)	5	-279.94	570.42	21.452	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-278.95	570.65	21.68	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-279.44	571.64	22.673	0
Ψ(ruderal.a +past.pop + connect + TotalS)p(.)	6	-279.47	571.7	22.732	0
Ψ(ruderal.prop +past.pop + connect)p(.)	6	-279.52	571.79	22.823	0
Ψ(field.prop + past.pop + connect)p(.)	5	-280.8	572.13	23.159	0
Ψ(lands.prop + past.pop + connect)p(.)	5	-280.8	572.13	23.16	0
Ψ(past.pop + connect + TotalS)p(.)	5	-280.92	572.37	23.394	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-280.93	572.4	23.432	0
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-281	572.53	23.561	0
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-280.81	574.38	25.409	0
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-280.88	574.52	25.546	0
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-280.16	575.33	26.363	0
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-285.4	583.56	34.589	0
Ψ(.)p(.)	2	-291.45	587	38.032	0
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-312.79	638.34	89.373	0

Rana temporaria larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-218.53	447.77	0	0.292
Ψ(connect)p(.)	3	-220.95	448.17	0.4	0.239
Ψ(wetland.prop)p(.)	3	-221.25	448.77	0.999	0.177
Ψ(Ruderal.prop)p(.)	3	-222.58	451.43	3.659	0.047
Ψ(.)p(.)	2	-223.95	452.04	4.264	0.035
Ψ(lands.prop)p(.)	3	-223.31	452.89	5.116	0.023
Ψ(Altitude + TotalS)p(.)	4	-222.31	453.09	5.314	0.021
Ψ(meadow.prop)p(.)	3	-223.63	453.53	5.76	0.016
Ψ(Freshwater.prop)p(.)	3	-223.65	453.57	5.796	0.016
Ψ(field area + TotalS)p(.)	4	-222.63	453.73	5.959	0.015
Ψ(buil.prop)p(.)	3	-223.77	453.81	6.036	0.014
Ψ(field.prop)p(.)	3	-223.94	454.15	6.377	0.012
Ψ(forest.prop)p(.)	3	-223.94	454.15	6.38	0.012
Ψ(past.pop)p(.)	3	-223.95	454.17	6.397	0.012
Ψ(TotalS)p(.)	3	-223.95	454.17	6.401	0.012
Ψ(Ruderal.a + TotalS)p(.)	4	-223.08	454.63	6.854	0.009
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-223.64	455.75	7.976	0.005
Ψ(Water.a + TotalS)p(.)	4	-223.67	455.81	8.036	0.005
Ψ(meadow.a + TotalS)p(.)	4	-223.73	455.92	8.144	0.005
Ψ(Wetland.a + TotalS)p(.)	4	-223.8	456.07	8.296	0.005
Ψ(Build.a + TotalS)p(.)	4	-223.81	456.08	8.306	0.005
Ψ(Freshwater.a + TotalS)p(.)	4	-223.84	456.15	8.377	0.004
Ψ(Forest.a+ TotalS)p(.)	4	-223.85	456.17	8.4	0.004
Ψ(Num.ponds + TotalS)p(.)	4	-223.88	456.23	8.457	0.004
Ψ(Lands.a + TotalS)p(.)	4	-223.9	456.26	8.489	0.004
Ψ(Temporary ponds)p(.)	4	-223.94	456.35	8.581	0.004

Bombina variegate all stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Temporary ponds + past.pop + field area + ruderal.prop TotalS)p(.)	7	-106.07	227.15	0	0.951
Ψ(ruderal.prop +past.pop + connect)p(.)	6	-110.55	233.85	6.701	0.033
Ψ(ruderal.a +past.pop + connect + TotalS)p(.)	6	-112.41	237.57	10.42	0.005
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-112.78	238.31	11.157	0.004
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-113.84	240.44	13.288	0.001
Ψ(field area + past.pop + connect + TotalS)p(.)	5	-115.63	241.79	14.635	0.001
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-115.68	241.89	14.741	0.001
Ψ(Wetland.prop + past.pop + connect)p(.)	6	-114.6	241.96	14.809	0.001
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-114.71	242.17	15.021	0.001
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	5	-115.92	242.38	15.222	0
Ψ(past.pop + connect + TotalS)p(.)	5	-116.08	242.69	15.538	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-116.51	243.55	16.394	0
Ψ(forest.prop + past.pop + connect)p(.)	6	-115.41	243.58	16.424	0
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	5	-116.55	243.63	16.477	0
Ψ(Build.prop + past.pop + connect)p(.)	6	-115.46	243.68	16.524	0
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-115.47	243.69	16.542	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-116.63	243.79	16.636	0
Ψ(field.prop + past.pop + connect)p(.)	6	-115.53	243.81	16.658	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-115.54	243.84	16.684	0
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	5	-116.66	243.85	16.694	0
Ψ(lands.prop + past.pop + connect)p(.)	6	-115.72	244.19	17.034	0
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-115.9	244.56	17.41	0
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	3	-119.49	245.18	18.03	0
Ψ(.)p(.)	2	-127.18	258.46	31.304	0

Bombina variegate larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Altitude + TotalS)p(.)	4	-39.42	88.83	0	0.135
Ψ(TotalS)p(.)	3	-40.92	88.98	0.144	0.126
Ψ(.)p(.)	2	-42.27	89.09	0.257	0.119
Ψ(ruderal.prop)p(.)	3	-42.25	91.64	2.811	0.033
Ψ(buil.prop)p(.)	3	-42.27	91.69	2.853	0.032
Ψ(meadow.prop)p(.)	3	-42.27	91.69	2.853	0.032
Ψ(Freshwater.prop)p(.)	3	-42.27	91.69	2.853	0.032
Ψ(past.pop)p(.)	3	-42.27	91.69	2.853	0.032
Ψ(forest.prop)p(.)	3	-42.27	91.69	2.853	0.032
Ψ(Temporary ponds + TotalS)p(.)	3	-42.27	91.69	2.857	0.032
Ψ(lands.prop)p(.)	3	-42.27	91.69	2.861	0.032
Ψ(connect)p(.)	4	-40.86	91.71	2.881	0.032
Ψ(field area + TotalS)p(.)	4	-40.91	91.82	2.991	0.03
Ψ(Water.a + TotalS)p(.)	4	-40.91	91.82	2.991	0.03
Ψ(Num.ponds + TotalS)p(.)	4	-40.91	91.82	2.991	0.03
Ψ(Ruderal.a+ TotalS)p(.)	4	-40.91	91.82	2.992	0.03
Ψ(Forest.a+ TotalS)p(.)	4	-40.91	91.82	2.992	0.03
Ψ(Build.a + TotalS)p(.)	4	-40.91	91.82	2.992	0.03
Ψ(Lands.a + TotalS)p(.)	4	-40.91	91.83	2.993	0.03
Ψ(Freshwater.a + TotalS)p(.)	4	-40.91	91.83	2.994	0.03
Ψ(Wetland.a + TotalS)p(.)	4	-40.91	91.83	2.995	0.03
Ψ(meadow.a + TotalS)p(.)	4	-40.92	91.83	2.998	0.03
Ψ(wetland.prop)p(.)	4	-41.61	93.22	4.385	0.015
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-40.91	94.98	6.148	0.006
Ψ(Num.ponds + Num.ponds ^2 + TotalS)p(.)	5	-40.91	94.98	6.149	0.006

***Bufo Bufo* all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Water.a + Freshwater.prop + past.pop)p(.)	5	-279.09	568.71	0	0.796
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-280.28	573.31	4.596	0.08
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-281.73	573.99	5.275	0.057
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-281.45	575.65	6.941	0.025
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-281.63	576.02	7.306	0.021
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-281.61	578.25	9.533	0.007
Ψ(past.pop + connect + TotalS)p(.)	5	-285.26	581.05	12.338	0.002
Ψ(Number temporary ponds + past.pop + connect + TotalS)p(.)	6	-284.29	581.33	12.62	0.001
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-284.3	581.36	12.644	0.001
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-284.67	582.09	13.375	0.001
Ψ(field.prop + past.pop + connect)p(.)	5	-285.89	582.32	13.612	0.001
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-284.84	582.44	13.724	0.001
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-284.85	582.45	13.741	0.001
Ψ(lands.prop + past.pop + connect)p(.)	5	-286.02	582.57	13.856	0.001
Ψ(ruderal.prop +past.pop + connect)p(.)	6	-285.09	582.93	14.222	0.001
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-285.13	583.03	14.313	0.001
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-285.15	583.06	14.343	0.001
Ψ(ruderal.a +past.pop + connect + TotalS)p(.)	6	-285.2	583.17	14.454	0.001
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-285.21	583.18	14.465	0.001
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-285.21	583.18	14.468	0.001
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-286.46	583.45	14.738	0.001
Ψ(forest.prop + past.pop + connect)p(.)	5	-286.51	583.56	14.845	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-286.56	583.66	14.951	0
Ψ(Build.prop + past.pop + connect)p(.)	5	-286.58	583.69	14.979	0
Ψ(.)p(.)	2	-291.98	588.06	19.352	0

***Bufo Bufo* larval stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Wetland.a)p(.)	3	-189.5	385.29	0	0.440
Ψ(Wetland.a + TotalS)p(.)	4	-189.29	387.06	1.771	0.181
Ψ(wetland.prop)p(.)	3	-191.42	389.12	3.83	0.065
Ψ(Freshwater.a + TotalS)p(.)	4	-190.68	389.84	4.551	0.045
Ψ(Ruderal.a + TotalS)p(.)	4	-190.88	390.24	4.952	0.037
Ψ(connect)p(.)	3	-192.42	391.13	5.84	0.024
Ψ(TotalS)p(.)	3	-192.44	391.16	5.871	0.023
Ψ(meadow.a + TotalS)p(.)	4	-191.45	391.37	6.082	0.021
Ψ(Temporary ponds)p(.)	4	-191.46	391.4	6.107	0.021
Ψ(Num.ponds + TotalS)p(.)	4	-191.58	391.63	6.344	0.018
Ψ(Water.a + TotalS)p(.)	4	-191.76	391.99	6.702	0.015
Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)	5	-190.65	392.02	6.729	0.015
Ψ(Lands.a + TotalS)p(.)	4	-191.86	392.19	6.897	0.014
Ψ(Forest.a+ TotalS)p(.)	4	-192.08	392.64	7.352	0.011
Ψ(field area + TotalS)p(.)	4	-192.13	392.73	7.437	0.011
Ψ(Build.a + TotalS)p(.)	4	-192.31	393.1	7.813	0.009
Ψ(Altitude + TotalS)p(.)	4	-192.32	393.12	7.831	0.009
Ψ(Ruderal.prop)p(.)	3	-193.47	393.22	7.926	0.008
Ψ(.)p(.)	2	-195.12	394.39	9.098	0.005
Ψ(past.pop)p(.)	3	-194.64	395.56	10.275	0.003
Ψ(lands.prop)p(.)	3	-194.72	395.72	10.435	0.002
Ψ(Freshwater.prop)p(.)	3	-194.8	395.88	10.594	0.002
Ψ(buil.prop)p(.)	3	-194.93	396.14	10.85	0.002
Ψ(forest.prop)p(.)	3	-195.06	396.39	11.104	0.002
Ψ(field.prop)p(.)	3	-195.06	396.4	11.106	0.002
Ψ(meadow.prop)p(.)	3	-195.09	396.46	11.171	0.002
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-194.25	396.97	11.683	0.001

Epidalea calamita all stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Temporary ponds + forest.prop + ruderal.prop)p(.)	5	-44.38	99.3	0	0.999
Ψ(ruderal.prop + past.pop + connect)p(.)	6	-50.81	114.37	15.068	0.001
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-52.24	117.24	17.94	0
Ψ(ruderal.a + past.pop + connect + TotalS)p(.)	6	-53.42	119.59	20.288	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-55.22	120.97	21.668	0
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-55.01	122.77	23.475	0
Ψ(.)p(.)	2	-59.35	122.8	23.504	0
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-55.15	123.05	23.751	0
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-56.32	123.17	23.871	0
Ψ(lands.prop + past.pop + connect)p(.)	5	-56.85	124.25	24.945	0
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-55.15	125.31	26.01	0
Ψ(Build.prop + past.pop + connect)p(.)	5	-58.08	126.7	27.396	0
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-57.26	127.28	27.984	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-58.41	127.36	28.061	0
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-57.44	127.63	28.332	0
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-58.61	127.75	28.453	0
Ψ(past.pop + connect + TotalS)p(.)	5	-58.64	127.81	28.51	0
Ψ(field.prop + past.pop + connect)p(.)	5	-58.65	127.84	28.538	0
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-57.97	128.69	29.395	0
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-58.22	129.19	29.887	0
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-57.14	129.29	29.994	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-58.39	129.55	30.246	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-58.51	129.77	30.471	0
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-58.52	129.79	30.488	0
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-58.53	129.82	30.522	0
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-58.64	130.04	30.742	0
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-57.98	130.98	31.675	0

Epidalea calamita larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(past.pop)p(.)	3	-21.5	53	0	0.414
Ψ(.)p(.)	2	-24.71	55.13	2.136	0.142
Ψ(Freshwater.prop)p(.)	3	-22.77	55.54	2.539	0.116
Ψ(Ruderal.prop)p(.)	3	-23.14	56.28	3.284	0.08
Ψ(lands.prop)p(.)	3	-23.19	56.39	3.392	0.076
Ψ(forest.prop)p(.)	3	-23.71	57.43	4.429	0.045
Ψ(buil.prop)p(.)	3	-24.36	58.73	5.732	0.024
Ψ(wetland.prop)p(.)	3	-24.52	59.03	6.036	0.02
Ψ(TotalS)p(.)	3	-24.59	59.17	6.177	0.019
Ψ(Altitude + TotalS)p(.)	4	-21.62	59.23	6.236	0.018
Ψ(meadow.prop)p(.)	3	-24.69	59.38	6.386	0.017
Ψ(connect)p(.)	3	-24.71	59.42	6.422	0.017
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-22.77	61.53	8.538	0.006
Ψ(Ruderal.a + TotalS)p(.)	4	-23.55	63.1	10.103	0.003
Ψ(Wetland.a + TotalS)p(.)	4	-24.36	64.72	11.719	0.001
Ψ(Water.a + TotalS)p(.)	4	-24.49	64.98	11.987	0.001
Ψ(meadow.a + TotalS)p(.)	4	-24.51	65.01	12.015	0.001
Ψ(Forest.a+ TotalS)p(.)	4	-24.59	65.17	12.177	0.001

Hyla arborea **all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Wetland.prop + past.pop + Freshwater.prop + Freshwater.prop^2)p(.)	5	-126.15	262.84	0	0.252
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-126.42	263.38	0.534	0.193
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-126.04	264.84	1.994	0.093
Ψ(Build.prop + past.pop + connect)p(.)	5	-127.37	265.27	2.426	0.075
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-126.36	265.48	2.633	0.068
Ψ(meadow.prop + past.pop + connect)p(.)	5	-127.95	266.43	3.584	0.042
Ψ(.)p(.)	5	-128.37	267.28	4.438	0.027
Ψ(past.pop + connect + TotalS)p(.)	2	-131.61	267.33	4.482	0.027
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	5	-128.41	267.35	4.508	0.026
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	6	-127.33	267.41	4.564	0.026
Ψ(lands.prop + past.pop + connect)p(.)	5	-128.88	268.29	5.447	0.017
Ψ(Water.a + past.pop + connect + TotalS)p(.)	5	-128.96	268.46	5.616	0.015
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-127.89	268.53	5.69	0.015
Ψ(forest.prop + past.pop + connect)p(.)	6	-127.9	268.55	5.711	0.014
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	5	-129.04	268.61	5.769	0.014
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-127.99	268.74	5.897	0.013
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-128.06	268.89	6.042	0.012
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-128.16	269.07	6.227	0.011
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-128.16	269.09	6.242	0.011
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-128.33	269.42	6.579	0.009
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-128.34	269.43	6.588	0.009
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-128.35	269.46	6.617	0.009
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-128.37	269.49	6.646	0.009
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	6	-128.4	269.56	6.712	0.009
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-128.3	271.63	8.782	0.003

Hyla arborea **larval stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(field.prop)p(.)	3	-21.25	49.59	0	0.278
Ψ(wetland.prop)p(.)	3	-22.1	51.29	1.698	0.119
Ψ(Ruderal.prop)p(.)	3	-22.24	51.57	1.983	0.103
Ψ(Freshwater.prop)p(.)	5	-19.55	52.1	2.511	0.079
Ψ(Water.a + Water.a^2 + TotalS)p(.)	3	-22.67	52.42	2.835	0.067
Ψ(meadow.prop)p(.)	2	-24.25	53.01	3.426	0.05
Ψ(.)p(.)	4	-21.75	53.41	3.827	0.041
Ψ(Freshwater.a + TotalS)p(.)	3	-23.18	53.46	3.868	0.04
Ψ(buil.prop)p(.)	3	-23.36	53.82	4.229	0.033
Ψ(connect)p(.)	4	-22.1	54.1	4.511	0.029
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-22.11	54.12	4.534	0.029
Ψ(Altitude + TotalS)p(.)	3	-23.52	54.12	4.536	0.029
Ψ(TotalS)p(.)	3	-23.99	55.07	5.487	0.018
Ψ(forest.prop)p(.)	3	-24.06	55.21	5.625	0.017
Ψ(lands.prop)p(.)	3	-24.2	55.49	5.9	0.015
Ψ(past.pop)p(.)	4	-23.13	56.17	6.583	0.01
Ψ(Build.a + TotalS)p(.)	4	-23.23	56.37	6.783	0.009
Ψ(Ruderal.a + TotalS)p(.)	4	-23.32	56.55	6.966	0.009
Ψ(meadow.a + TotalS)p(.)	4	-23.43	56.75	7.168	0.008
Ψ(Lands.a + TotalS)p(.)	4	-23.46	56.82	7.234	0.007
Ψ(Forest.a+ TotalS)p(.)	4	-23.46	56.83	7.242	0.007
Ψ(Num.ponds + TotalS)p(.)	5	-22.72	58.44	8.858	0.003

***Hyla intermedia all* stage**

Models	***K***	***logLik***	***AICc***	***ΔAICc***	***w***
Ψ(Altitude + connect + TotalS)p(.)	5	-64.95	142.04	0	0.550
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-64.12	143.35	1.311	0.285
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-66.25	147.6	5.564	0.034
Ψ(Build.prop + past.pop + connect)p(.)	5	-67.9	147.94	5.901	0.029
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-66.78	148.68	6.638	0.02
Ψ(past.pop + connect + TotalS)p(.)	5	-68.42	148.97	6.935	0.017
Ψ(.)p(.)	2	-72.75	149.88	7.84	0.011
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-68.04	151.18	9.145	0.006
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-68.06	151.23	9.195	0.006
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-68.18	151.47	9.436	0.005
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-68.18	151.48	9.438	0.005
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-68.23	151.58	9.541	0.005
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-68.32	151.76	9.72	0.004
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-68.34	151.8	9.761	0.004
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-68.35	151.82	9.782	0.004
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-69.98	152.1	10.064	0.004
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-70.12	152.38	10.346	0.003
Ψ(lands.prop + past.pop + connect)p(.)	5	-70.58	153.31	11.271	0.002
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-70.6	153.34	11.297	0.002
Ψ(meadow.prop + past.pop + connect)p(.)	5	-70.6	153.34	11.305	0.002
Ψ(forest.prop + past.pop + connect)p(.)	5	-70.72	153.58	11.545	0.002
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-69.86	154.83	12.792	0.001
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-68.29	154.89	12.854	0.001

***Ichthyosaura alpestris* all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Altitude + Number.ponds + fieldarea + Num.ponds^2+ past.pop + connect)p(.)	9	-198.92	417.51	0	0.834
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-205.5	423.76	6.251	0.037
Ψ(field.a + past.pop + connect + TotalS)p(.)	6	-205.93	424.61	7.1	0.024
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-204.95	424.92	7.41	0.021
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-206.48	425.71	8.203	0.014
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-206.86	426.49	8.978	0.009
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-206.87	426.49	8.987	0.009
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-207.39	427.54	10.034	0.006
Ψ(past.pop + connect + TotalS)p(.)	5	-208.51	427.56	10.054	0.005
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-207.44	427.64	10.135	0.005
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-207.8	428.36	10.849	0.004
Ψ(meadow.prop + past.pop + connect)p(.)	5	-209.06	428.65	11.145	0.003
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-209.14	428.82	11.317	0.003
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-208.09	428.94	11.436	0.003
Ψ(forest.prop + past.pop + connect)p(.)	5	-209.25	429.04	11.535	0.003
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-208.16	429.09	11.578	0.003
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-208.24	429.24	11.735	0.002
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-209.44	429.42	11.913	0.002
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-208.43	429.61	12.1	0.002
Ψ(Build.prop + past.pop + connect)p(.)	5	-209.54	429.61	12.105	0.002
Ψ(lands.prop + past.pop + connect)p(.)	5	-209.55	429.64	12.137	0.002
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-209.59	429.71	12.199	0.002
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-208.5	429.77	12.26	0.002
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	6	-208.51	429.78	12.275	0.002
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-207.61	430.24	12.736	0.001
Ψ(.)p(.)	7	-208.35	431.71	14.205	0.001

***Ichthyosaura alpestris* larval stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(field.prop)p(.)	3	-117.37	241.07	0	0.993
Ψ(connect)p(.)	3	-123.98	254.29	13.218	0.001
Ψ(Num.ponds + TotalS)p(.)	4	-123.03	254.61	13.537	0.001
Ψ(lands.prop)p(.)	3	-124.42	255.17	14.1	0.001
Ψ(Num.ponds + Num.ponds ^2 + TotalS)p(.)	5	-122.51	255.87	14.798	0.001
Ψ(.)p(.)	2	-126.23	256.62	15.556	0
Ψ(Temporary ponds)p(.)	4	-124.08	256.71	15.641	0
Ψ(wetland.prop)p(.)	3	-125.2	256.73	15.659	0
Ψ(forest.prop)p(.)	3	-125.26	256.85	15.777	0
Ψ(buil.prop)p(.)	3	-125.4	257.12	16.055	0
Ψ(past.pop)p(.)	3	-125.7	257.73	16.658	0
Ψ(Lands.a + TotalS)p(.)	4	-124.94	258.44	17.371	0
Ψ(meadow.prop)p(.)	3	-126.17	258.67	17.601	0
Ψ(Freshwater.prop)p(.)	3	-126.19	258.71	17.638	0
Ψ(Ruderal.prop)p(.)					
Ψ(TotalS)p(.)	3	-126.23	258.78	17.713	0
Ψ(Forest.a+ TotalS)p(.)	4	-125.6	259.76	18.692	0
Ψ(Wetland.a + TotalS)p(.)	4	-126.01	260.57	19.498	0
Ψ(Altitude + TotalS)p(.)	4	-126.02	260.59	19.522	0
Ψ(Water.a + TotalS)p(.)	4	-126.06	260.69	19.616	0
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-124.98	260.8	19.732	0
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-126.14	260.83	19.761	0
Ψ(Ruderal.a + TotalS)p(.)					
Ψ(meadow.a + TotalS)p(.)	4	-126.17	260.89	19.826	0
Ψ(Build.a + TotalS)p(.)	4	-126.2	260.95	19.883	0
Ψ(Freshwater.a + TotalS)p(.)	4	-126.22	261	19.931	0

***Lissotriton helveticus* all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Meadow.prop + past.pop+ connect)p(.)	5	-167.22	344.98	0	0.243
Ψ(forest.prop + past.pop + connect)p(.)	5	-167.82	346.17	1.183	0.134
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-167.23	347.21	2.224	0.08
Ψ(Field area + past.pop + connect + TotalS)p(.)	6	-167.24	347.23	2.242	0.079
Ψ(Meadow.a + past.pop + connect + TotalS)p(.)	5	-168.41	347.35	2.368	0.074
Ψ(ruderal.a + past.pop + connect + TotalS)p(.)	6	-167.68	348.12	3.139	0.051
Ψ(past.pop + connect + TotalS)p(.)	5	-169.07	348.67	3.687	0.038
Ψ(Build.prop + past.pop + connect)p(.)	5	-169.1	348.73	3.741	0.037
Ψ(Lands.prop + past.pop + connect)p(.)	5	-169.11	348.75	3.768	0.037
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-169.37	349.28	4.296	0.028
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-169.43	349.41	4.421	0.027
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-168.68	350.12	5.135	0.019
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-168.84	350.44	5.453	0.016
Ψ(Meadow.a + past.pop + connect + TotalS)p(.)	6	-168.87	350.5	5.518	0.015
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-168.88	350.52	5.539	0.015
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-168.89	350.54	5.559	0.015
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-168.9	350.55	5.565	0.015
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-168.93	350.62	5.631	0.015
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-167.89	350.79	5.804	0.013
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-169.06	350.89	5.9	0.013
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-169.06	350.89	5.901	0.013
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-169.07	350.89	5.908	0.013
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-169.33	351.41	6.429	0.01
Ψ(.)p(.)	2	-196.79	397.69	52.7	0
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-216.3	447.61	102.63	0

***Lissotriton helveticus* larval stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(field.prop)p(.)	3	-43.08	92.67	0	0.723
Ψ(field area + TotalS)p(.)	4	-43.26	95.39	2.716	0.186
Ψ(.)p(.)	2	-48.28	100.8	8.129	0.012
Ψ(Freshwater.prop)p(.)	3	-47.54	101.6	8.925	0.008
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-45.13	101.6	8.931	0.008
Ψ(Freshwater.a + TotalS)p(.)	4	-46.66	102.19	9.518	0.006
Ψ(wetland.prop)p(.)	3	-47.85	102.2	9.529	0.006
Ψ(connect)p(.)	3	-48.13	102.76	10.09	0.005
Ψ(lands.prop)p(.)	3	-48.13	102.77	10.099	0.005
Ψ(meadow.prop)p(.)	3	-48.17	102.84	10.17	0.004
Ψ(past.pop)p(.)	3	-48.2	102.91	10.234	0.004
Ψ(forest.prop)p(.)	3	-48.2	102.91	10.239	0.004
Ψ(TotalS)p(.)	3	-48.25	103.02	10.347	0.004
Ψ(buil.prop)p(.)	3	-48.27	103.06	10.388	0.004
Ψ(Build.a + TotalS)p(.)	4	-47.35	103.57	10.898	0.003
Ψ(Wetland.a + TotalS)p(.)	4	-47.47	103.82	11.146	0.003
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-47.5	103.88	11.206	0.003
Ψ(Forest.a+ TotalS)p(.)	4	-47.88	104.64	11.964	0.002
Ψ(Num.ponds + TotalS)p(.)	4	-47.88	104.64	11.966	0.002
Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)	5	-46.66	104.64	11.972	0.002
Ψ(Num.ponds + Num.ponds ^2 + TotalS)p(.)	5	-46.79	104.92	12.248	0.002
Ψ(meadow.a + TotalS)p(.)	4	-48.14	105.16	12.483	0.001
Ψ(Lands.a + TotalS)p(.)	4	-48.17	105.21	12.537	0.001
Ψ(Altitude + TotalS)p(.)	4	-48.2	105.26	12.592	0.001

Pelophylax sp. All stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Num.ponds + Num.ponds^2 + connect)p(.)	5	-277.41	565.36	0	0.691
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-276.22	567.46	2.1	0.242
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-279.9	572.56	7.204	0.019
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-280.18	573.12	7.764	0.014
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-281.07	574.9	9.545	0.006
Ψ(past.pop + connect + TotalS)p(.)	5	-282.72	575.97	10.61	0.003
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-281.65	576.06	10.704	0.003
Ψ(Number temporary ponds + past.pop + connect + TotalS)p(.)	6	-281.67	576.1	10.739	0.003
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-281.79	576.34	10.982	0.003
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-281.82	576.41	11.048	0.003
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-282.21	577.18	11.825	0.002
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-282.4	577.55	12.19	0.002
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-282.4	577.56	12.202	0.002
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-281.41	577.85	12.489	0.001
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-282.56	577.89	12.529	0.001
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-282.57	577.89	12.53	0.001
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-282.69	578.14	12.781	0.001
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-281.82	578.67	13.308	0.001
Ψ(.)p(.)	2	-287.83	579.77	14.412	0.001
Ψ(Lands.prop + past.pop + connect)p(.)	5	-284.69	579.92	14.564	0
Ψ(Build.prop + past.pop + connect)p(.)	5	-285.65	581.83	16.476	0
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-285.8	582.13	16.769	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-285.85	582.24	16.88	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-286	582.53	17.172	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-286	582.54	17.183	0
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-286.01	582.56	17.203	0
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-285.81	584.38	19.023	0

***Pelophylax sp.* larval stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(field.prop)p(.)	4	-86.39	181.27	0	0.410
Ψ(Wetland.a + TotalS)p(.)	3	-87.59	181.48	0.201	0.371
Ψ(Ruderal.a + TotalS)p(.)	4	-88.59	185.67	4.4	0.045
Ψ(Temporary ponds + Total S)p(.)	4	-89.07	186.64	5.367	0.028
Ψ(Lands.a + TotalS)p(.)	4	-89.26	187.02	5.744	0.023
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-89.37	187.23	5.955	0.021
Ψ(Altitude + TotalS)p(.)	4	-89.86	188.21	6.934	0.013
Ψ(TotalS)p(.)	3	-91.03	188.35	7.072	0.012
Ψ(.)p(.)	2	-92.13	188.4	7.126	0.012
Ψ(lands.prop)p(.)	3	-91.09	188.46	7.19	0.011
Ψ(Freshwater.a + TotalS)p(.)	4	-90.21	188.92	7.643	0.009
Ψ(buil.prop)p(.)	3	-91.73	189.76	8.486	0.006
Ψ(Num.ponds + TotalS)p(.)	4	-90.67	189.83	8.559	0.006
Ψ(forest.prop)p(.)	3	-91.79	189.86	8.589	0.006
Ψ(field area + TotalS)p(.)	4	-90.74	189.96	8.69	0.005
Ψ(past.pop)p(.)	3	-92	190.29	9.014	0.005
Ψ(Forest.a+ TotalS)p(.)	4	-91.02	190.54	9.263	0.004
Ψ(Freshwater.prop)p(.)	3	-92.12	190.54	9.267	0.004
Ψ(meadow.prop)p(.)	3	-92.12	190.54	9.268	0.004
Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)	5	-90.21	191.17	9.9	0.003
Ψ(Num.ponds + Num.ponds ^2 + TotalS)p(.)	5	-90.59	191.93	10.653	0.002
Ψ(Water.a + Water.a^2 + TotalS)p(.)	5	-91.01	192.76	11.488	0.001

Rana dalmatina all stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Freshwater.prop + past.pop + Altitude + field area)p(.)	6	-122.05	256.86	0	0.968
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-128.09	266.71	9.856	0.007
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-125.96	266.93	10.074	0.006
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-127.32	267.4	10.538	0.005
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-127.48	267.72	10.857	0.004
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-126.87	268.75	11.893	0.003
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-128.03	268.82	11.964	0.002
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-130.74	272.01	15.153	0
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-129.8	272.35	15.495	0
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-129.81	272.38	15.519	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-131.06	272.65	15.795	0
Ψ(past.pop + connect + TotalS)p(.)	5	-131.24	273.02	16.161	0
Ψ(lands.prop + past.pop + connect)p(.)	5	-131.5	273.54	16.683	0
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-130.41	273.58	16.721	0
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-130.42	273.59	16.734	0
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-131.6	273.73	16.873	0
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-130.53	273.82	16.963	0
Ψ(Build.prop + past.pop + connect)p(.)	5	-131.75	274.03	17.17	0
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-130.66	274.08	17.224	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-131.78	274.1	17.237	0
Ψ(Temporary ponds + past.pop + connect + TotalS)p(.)	6	-130.7	274.15	17.296	0
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-130.84	274.45	17.587	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-130.85	274.47	17.608	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-131.22	275.2	18.341	0
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-131.23	275.23	18.367	0
Ψ(.)p(.)	2	-152.11	308.33	51.47	0

Rana dalmatina larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Altitude + Num.ponds)p(.)	4	-72.08	153.53	0	0.531
Ψ(Altitude + TotalS)p(.)	4	-72.31	154	0.464	0.421
Ψ(.)p(.)	2	-79.23	162.85	9.32	0.005
Ψ(forest.prop)p(.)	3	-78.15	163.1	9.566	0.004
Ψ(Num.ponds + TotalS)p(.)	4	-78.31	163.42	9.884	0.004
Ψ(wetland.prop)p(.)	3	-78.31	163.42	9.886	0.004
Ψ(Ruderal.prop)p(.)	3	-78.31	163.42	9.892	0.004
Ψ(Freshwater.prop)p(.)	3	-78.53	163.86	10.331	0.003
Ψ(field.prop)p(.)	3	-78.54	163.89	10.358	0.003
Ψ(lands.prop)p(.)	3	-77.34	164.05	10.521	0.003
Ψ(Temporary ponds + TotalS)p(.)	4	-78.97	164.74	11.209	0.002
Ψ(meadow.prop)p(.)	3	-79.05	164.89	11.362	0.002
Ψ(past.pop)p(.)	3	-79.08	164.95	11.42	0.002
Ψ(buil.prop)p(.)	3	-77.82	165.02	11.487	0.002
Ψ(Forest.a+ TotalS)p(.)	4	-79.14	165.08	11.549	0.002
Ψ(connect)p(.)	3	-79.22	165.23	11.7	0.002
Ψ(TotalS)p(.)	3	-79.22	165.25	11.715	0.002
Ψ(field area + TotalS)p(.)	4	-78.11	165.6	12.07	0.001
Ψ(Freshwater.prop + Freshwater.prop^2 + TotalS)p(.)	4	-78.12	165.62	12.087	0.001
Ψ(Lands.a + TotalS)p(.)	4	-78.67	166.72	13.192	0.001
Ψ(Wetland.a + TotalS)p(.)	4	-78.91	167.2	13.666	0.001
Ψ(Freshwater.a + TotalS)p(.)	4	-79.08	167.55	14.014	0
Ψ(meadow.a + TotalS)p(.)	4	-79.18	167.74	14.205	0
Ψ(Build.a + TotalS)p(.)	4	-79.18	167.75	14.216	0
Ψ(Ruderal.a + TotalS)p(.)	4	-79.21	167.8	14.265	0

Triturus carnifex **all stage**

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(forest area)p(.)	3	-58.98	124.75	0	0.834
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	6	-57.76	130.62	5.868	0.044
Ψ(.)p(.)	2	-63.56	131.5	6.748	0.029
Ψ(Field area + past.pop + connect + TotalS)p(.)	6	-58.52	132.14	7.388	0.021
Ψ(Meadow.a + past.pop + connect + TotalS)p(.)	6	-59.22	133.56	8.805	0.01
Ψ(Past.pop + connect + TotalS)p(.)	5	-60.81	133.76	9.007	0.009
Ψ(Build.prop + past.pop + connect)p(.)	5	-60.93	134	9.243	0.008
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-59.94	134.99	10.231	0.005
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-59.99	135.1	10.344	0.005
Ψ(Forest.prop + past.pop + connect)p(.)	5	-61.57	135.29	10.539	0.004
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-60.14	135.39	10.632	0.004
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-61.66	135.47	10.712	0.004
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-60.61	136.34	11.583	0.003
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-60.64	136.39	11.639	0.002
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-60.73	136.57	11.815	0.002
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-60.74	136.59	11.834	0.002
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-60.79	136.69	11.94	0.002
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-60.8	136.71	11.952	0.002
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-60.8	136.72	11.967	0.002
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-62.85	137.84	13.089	0.001
Ψ(Temporary ponds + Num.ponds + past.pop + connect + TotalS)p(.)	7	-59.81	137.93	13.172	0.001
Ψ(meadow.prop + past.pop + connect)p(.)	5	-63.04	138.22	13.469	0.001
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-63.07	138.28	13.528	0.001
Ψ(lands.prop + past.pop + connect)p(.)	5	-63.11	138.37	13.614	0.001
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-60.48	139.27	14.519	0.001
Ψ(Freshwater.a + Freshwater.a^2 + past.pop + connect + TotalS)p(.)	7	-60.67	139.65	14.898	0
Ψ(Water.a + Water.a^2 + past.pop + connect + TotalS)p(.)	7	-60.68	139.66	14.905	0

Lissotriton vulgaris all stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(Num.ponds + Freshwater.prop + Still.waterprop^2 + Lands.a + past.pop)p(.)	7	-98.87	212.75	0	0.997
Ψ(Freshwater.prop + Freshwater.prop^2 + past.pop + connect + TotalS)p(.)	6	-106.47	225.69	12.936	0.002
Ψ(Lands.a + past.pop + connect + TotalS)p(.)	6	-107.89	228.54	15.783	0
Ψ(Wetland.prop + past.pop + connect)p(.)	5	-109.37	229.29	16.532	0
Ψ(lands.prop + past.pop + connect)p(.)	5	-110.11	230.75	18.002	0
Ψ(Build.prop + past.pop + connect)p(.)	5	-110.21	230.96	18.206	0
Ψ(Num.ponds + past.pop + connect + TotalS)p(.)	6	-109.32	231.39	18.641	0
Ψ(Build.a + past.pop + connect + TotalS)p(.)	6	-109.56	231.87	19.121	0
Ψ(Ruderal.a + past.pop + connect + TotalS)p(.)	6	-109.58	231.92	19.171	0
Ψ(Number temporary ponds + past.pop + connect + TotalS)p(.)	7	-108.63	232.27	19.515	0
Ψ(Num.ponds + Num.ponds^2 + past.pop + connect + TotalS)p(.)	7	-108.79	232.61	19.855	0
Ψ(meadow.prop + past.pop + connect)p(.)	5	-111.19	232.92	20.168	0
Ψ(Freshwater.prop + past.pop + connect + TotalS)p(.)	5	-111.35	233.23	20.475	0
Ψ(past.pop + connect + TotalS)p(.)	5	-111.46	233.46	20.706	0
Ψ(Forest.a+ past.pop + connect + TotalS)p(.)	5	-111.47	233.47	20.714	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	5	-111.57	233.68	20.929	0
Ψ(Altitude + past.pop + connect + TotalS)p(.)	6	-110.47	233.7	20.946	0
Ψ(forest.prop + past.pop + connect)p(.)	5	-111.6	233.74	20.989	0
Ψ(Wetland.a + past.pop + connect + TotalS)p(.)	6	-111.09	234.93	22.177	0
Ψ(Ruderal.prop + past.pop + connect)p(.)	6	-111.11	234.97	22.215	0
Ψ(Freshwater.a + past.pop + connect + TotalS)p(.)	6	-111.34	235.44	22.685	0
Ψ(meadow.a + past.pop + connect + TotalS)p(.)	6	-111.39	235.53	22.775	0
Ψ(Water.a + past.pop + connect + TotalS)p(.)	6	-111.4	235.56	22.805	0
Ψ(field area + past.pop + connect + TotalS)p(.)	6	-111.46	235.68	22.927	0
Ψ(.)p(.)	2	-116.07	236.24	23.488	0
Ψ(Freshwater.a + Freshwater.a^2 + TotalS)p(.)	7	-111.34	237.7	24.95	0

Lissotriton vulgaris larval stage

Models	*K*	*logLik*	*AICc*	*ΔAICc*	*w*
Ψ(.)p(.)	2	-31.15	66.92	0	0.164
Ψ(lands.prop)p(.)	3	-30.25	67.84	0.917	0.104
Ψ(TotalS)p(.)	3	-30.34	68.02	1.094	0.095
Ψ(meadow.prop)p(.)	3	-30.77	68.88	1.959	0.062
Ψ(Wetland.a + TotalS)p(.)	4	-29.28	68.91	1.987	0.061
Ψ(wetland.prop)p(.)	4	-29.37	69.1	2.173	0.056
Ψ(buil.prop)p(.)	3	-31.02	69.38	2.452	0.048
Ψ(past.pop)p(.)	3	-31.04	69.41	2.492	0.047
Ψ(connect)p(.)	3	-31.11	69.56	2.633	0.044
Ψ(forest.prop)p(.)	3	-31.11	69.56	2.64	0.044
Ψ(Freshwater.prop)p(.)	3	-31.12	69.57	2.645	0.044
Ψ(Lands.a + TotalS)p(.)	4	-29.84	70.04	3.118	0.035
Ψ(Forest.a+ TotalS)p(.)	4	-29.97	70.29	3.368	0.031
Ψ(field area + TotalS)p(.)	4	-30.18	70.71	3.791	0.025
Ψ(meadow.a + TotalS)p(.)	4	-30.19	70.73	3.81	0.024
Ψ(Water.a + TotalS)p(.)	4	-30.24	70.83	3.909	0.023
(Num.ponds + TotalS)p(.)	4	-30.3	70.96	4.04	0.022
Ψ(Freshwater.a + TotalS)p(.)	4	-30.32	70.99	4.067	0.022
Ψ(Build.a + TotalS)p(.)	4	-30.34	71.04	4.113	0.021
Ψ(Num.ponds + Number Temporary ponds)	4	-30.84	72.03	5.108	0.013