Conservation networks do not match ecological requirements of amphibians

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Revision round #1

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Dear editor and reviewers,

First of all, I'm sorry for the delay for the resubmission of this manuscript. I have incorporated your comments as best as I can and I carried out additional analyses for the major comments.

Best regards,

Florence Matutini

Review by Peter Vermeiren, 24 Oct 2022 13:51

Thank you for the opportunity to review this manuscript. This work builds on previous species distribution models for 9 amphibians, by combining them into multi-species suitability maps. Connectivity among highly suitable habitats is then assessed, as well as overlap with existing protected areas and green infrastructure. The manuscript addresses a very relevant issue via a clear and well-structured methodological approach. The introduction and discussion also place the work and its limitations into a broader context. I enjoyed reading this manuscript.

One question that came up with me is that a selection of nine species of amphibians were investigated. Nevertheless, there are many more amphibians. The manuscript mentions amphibians in general when discussing the results. It would be worthwhile to discuss the relevance/transferability of the results to amphibians in general. How representative are the results for other amphibians. (I saw that some correlation between the multi-species suitability maps and independent data on amphibian species richness was made, perhaps this is a result that can be discussed a bit more in this context).

*** Thank you for the comment. We have carried out additional analyses in an additional appendix (Appendix 1) and added elements to the discussion (see below).

The appendix includes:

(1) A presentation of data used by Matutini et al. 2021 for Species distribution modelling (calibration and validation)

(2) A representation of the available presence data (500m-presence cells i.e. with at least one presence) for the rarer species present in the region according to the different suitability gradients modelled for the 3 groups of species (ALL, FOR, GEN) and for two individual species: *Pelodytes punctatus* and *Triturus marmoratus*. These two species have contrasting ecological requirements and are considered as two target species (or "umbrella species") for the development and monitoring of the regional Green and Blue infrastructure. We see in particular on these graphs that our results are consistent for rarer species such as ICHALP (forest species, with a strong selection of the most suitable habitat (>80%) modelled for the FOR group), LISVUL (fairly little known species associated with grassland near streams, with a strong selection of the most suitable habitat (>80%) modelled for the GEN group), TRIBLA (with a selection of the most suitable habitat (>80%) modelled for the GEN and FOR group; which seems coherent since TRIBLA is a hybrid between TRIMAR and TRICRI). The results are less pronounced for ALYOBS and EPICAL which are however not species present in agricultural areas and therefore not targeted by our studies (we can however notice a selection by EPICAL of certain habitats most suitable to PELPUN, which is also consistent since they are two pioneer species associated with open sandy environments)

(3) A Table with the proportion of presence data covered by the conservation area (conservation coverage) for species not included in species distribution modelling (an extension of the Table 4). These results show that protected areas with a high level of protection (PA group 1) cover a very small proportion of the known data for the “rare” species with the exception of PELCUL (*Pelodates cultripes*) as expected in the discussion. We add elements in the discussion on these points. Note that PELCUL is however a species at the limit of its distribution in the studied region.

A second issue that I wondered about is how sensitive the results are to the suitability classification scheme. For example, highly suitable are those areas with a score > 80%. Would the results look very different if you used a different threshold, e.g. 75 or 85%?

*** We have added an appendix representing the results of habitat suitability maps with different thresholds of 75%, 80% and 85% (Appendix 4 Figure S4.2). We can see that the “bottleneck” effect is still visible for forest/bocage species, which underlines the results obtained initially. Moreover, concerning the coverage of protected areas, Figure 2 shows the distribution of APs along the gradients of suitability without threshold values. With the exception of *Pelodyted punctatus*, we see in this figure that the APs do not or barely cover the most suitable areas identified, whatever threshold value is used.

Apart from that I only have very minor suggestions, regarding clarification:

L. 176 – 179: This sentence is rather hard to understand. Please explain in more detail what is meant with “the ecological context of our region” and how/why this leads you to aggregate the 100m pixels into 500m pixels. Also, please briefly explain why the maximum suitability was taken, wouldn’t this overestimate the suitability?

***add l188 “(i.e. a hedgerow landscape with small, interlinked landscape elements)

L. 185: It is not clear to me how the R2 value was calculate with 500 iterations. (What differs between the iterations?)

*** For each iteration, the evaluation-set was built by randomly selecting the pixels (500m) containing evaluation data while respecting a distance of 1km between each (independence) and stratifying along the suitability gradient of the predicted habitat map (methods tested and validated in Matutini et al. 2021). Evaluation metrics for multi-species maps are still debated. Individual AUC and SEDI are more robust and minimal AUC values of individual maps are all greater than 0.70 which is considered satisfactory (and realistic) in the literature. The complementary results shown in Appendix 1 (in response to your first comment) also provide an interesting evaluation and underline the consistency of our results.

L. 195: I think the correct English should read “suitability index above 80%”. “Up to” would be everything below 80%. Please check.

*** ok

L. 217 - 219: This sentence is unclear. With “studied region” you mean the whole Pays-de-la-Loire region? Do you mean that resistance values were randomly chosen in this buffer strip in case you did not have land-cover data (and thus could not calculate resistance values)?

*** Yes that’s right

Fig 2. A minor suggestion: It would be quite easy to divide the multi-species suitability index by the number of species summed over, in order to have suitability indices that are always on the same scale (0-1) for easy and quick comparison among the graphs.

*** ok we modified the Figure 2

L. 318: Obtained instead of obtain, and highlights instead of highlight

*** ok

Review by anonymous reviewer, 14 Nov 2022 21:05

This manuscript “Conservation networks do not match ecological requirements of amphibians” is relevant in the domain of the conservation biology. The writing and logic in the manuscript were easy to follow and the results are interesting. However, I think the manuscript lacks details about the methodology to determine their real ecologic significance. I have several major comments.

Firstly, what sort of detection and survey method was used in this study? The authors worked on 9 amphibian species that have very different ecological preferences and constraints.

Therefore, it is important to specify in the materials and methods how the data concerning the presence of the species in the different sites were acquired. I understand that the data are issued from participatory sciences and expert knowledge. But, even if the authors refer to already published articles, it is necessary to specify if the survey was done randomly or only on sites favourable to amphibians. Was it a daytime survey, a nighttime survey, a net survey? What is the probability of detection of each species with this method? have you adapted the survey effort to the probability of detection for each of the 9 species studied?

*** We have described the data, filtering methods for calibration and evaluation sets and the choice of pseudo-absences (calibration set only) only succinctly because these aspects are detailed in a previous publication focusing on the data and methods. This enables us to keep the article to a maximum of 8000 words. Nonetheless, we have added some elements and additional information to Appendix 1 (data source and description) so that readers do not have to refer to previous publications for main information.

We also added the following elements to the main text :

l177-184 : Model calibration sets were opportunistic presence-only data from a regional Atlas project with distance-based filtering to reduce spatial autocorrelation coupled to a weighted pseudo-absence selection to reduce sampling bias. SDM were performed combining Random Forest and General additive models. An independent and standardised detection-nondetection dataset, stratified by model predictions for each species, were used for a robust model evaluation. This dataset included 576 ponds monitored by experts at least 2 nights with a 5-min acoustic survey followed by a visual inspection using halogen light and a direct sampling using a fishing net. Data are described Appendix 1.

Secondly, how is the coefficient of friction calculated for the different species? Is the friction coefficient per habitat depending on the species considered? Indeed, for example, the friction coefficient of an habitat for animals that move on the ground (bufo spinosus) is very different from that, for the same habitat, for animals that move in trees (Hyla arborea)?

*** No, the friction coefficients were defined for each group of species (Appendix 3), even if these included species with different dispersal capacities (we considered the strongest resistance value, i.e. targeted the less mobile species as a precaution). In addition, the scientific literature lacks information on the movement of these species so we applied a precautionary principle, trying to be realistic and aware of the limits.

For this stage, the objective was above all to obtain the first distributions at fairly coarse resolutions and we considered these results as preliminary in the discussion, without overinterpretation.

Finally, I do not know the IUCN classification of protection areas. Nevertheless, I am really surprised by the authors' choice to include ENS and PNR in the protection area. What are the specific regulatory protection measures for amphibians in these areas? To my knowledge, none. Do the ENS of this study have specific regulations? Why are the Natura 2000 areas that have a regulatory status in group 3? (lines 152-162 ; Table 2).

*** We have corrected Table 2 to consider these comments and to clarified the level of protection. We considered Natura2000 to be a separate group because it does not appear in the national interpretations of the IUCN classification (European legislation) and is not equivalent

to either group 1 or group 2 in terms of regulations. We consider the Natura2000 network to offer a higher level of protection than PNRs. For the SCEN/ENS group, though the level of legal protection is generally limited, in practice it varies considerably between sites.

Minor comments:

Line 72: In this study, the authors consider only the green infrastructures. Nowhere is mentioned the blue infrastructures which are particularly important for amphibians (tadpoles but also adults). In conservation policies, green and blue infrastructures are often associated. (Line 83) Does the term "wetlands" refer to the blue part of green infrastructures? Did the authors take ditches into account in their study? Ditches are very important for the movement of amphibians.

*** Yes, "wetlands" refer to the blue part of “blue and green” infrastructures but are separate from linear aquatic elements such as streams and rivers. Ditches have not been included in the wetland infrastructures as digitised data of these elements are not available. However, in our models (SDM in previous study and in friction values in this studies), we tried to include the effect of ditches considering that the probability to have a ditch was higher when you have a pathway (dirt track ; permeable driveway) out of urban area (see Appendix 4). Thus, we allocated a low friction value to these pathways, as for minor streams.

We added precisions l74 Green infrastructure (GI) (also called Green and Blue infrastructure in France)

Line 86: I disagree that charismatic species are poorly representative of species-habitat relationships. In many case, charismatic species are considered as umbrella species that are important in terms of protection.

*** This was a reference to Rodrigues et al. 2004. It depends on the definition one gives to “charismatic species” which is subjective (amphibians are often considered as not charismatic… less than wolves for example). In addition, species that might be considered “charismatic” in our region (from the naturalist’s point of view) are usually rare species not specially related to agricultural landscapes.

Line 98-102: I am not sure that in Western Europe, traditional hedgerows landscapes have a high density of ponds. This is true in the western of France but it is probably not the general case in Europe.

*** We have corrected the text to state that high pond density is a characteristic of France and its hedgerow network landscapes.

Line 110: Amphibian skin is permeable and not impermeable

*** ok

Line 156: I do not understand what the authors mean line156-157 (For two types of Pas, site boundaries were not available.)

*** We mean that mapped site boundaries were not available and so instead of using sites polygons we included only points representing each site in the analysis.

Line 248-256: Does this mean that 1% of the amphibian habitat in the study area is in Group 1, or does it mean that only 1% of the amphibian habitat is in Group 1?

*** It means that Group 1 of PA covered 1% of the "highly suitable habitat". This is clearer with the representation in Table 4 (2).

The article would be improved if species-specific data were included in the results so that interspecific variability in results could be assessed.

*** We chose to include species-specific analysis for 3 species of highest conservation concern : *Triturus marmoratus*, *Rana temporaria* and *Pelodytes punctatus*.

Although the study focuses on the importance of PAs and GI to amphibians, biodiversity is not just about these species. The authors could comment this point in the discussion.

We have added some comments at the end of the discussion to indicate the potential indicator value of amphibians and to link this research with wider biodiversity conservation in mosaic landscapes.

In addition we added some minor modification to clarified the manuscript according to these comments:

For clarification of the aim: l120-125 "The aim of this study is to propose a method to assess the ecological quality of agricultural mosaics landscapes from species data and to conduct a gap analysis on existing conservation networks. In a human-dominated region of western France with high conservation issues related to traditional hedgerow landscapes, we compared the predicted habitat requirements of amphibian species with existing conservation network coverage (of both protected areas and green infrastructure)."

And some elements in the discussion related to the Other effective area-based conservation measures (OECMs) a new conservation tool define by the Convention on Biological Diversity (2018).

L450 : Overall, the protected areas network needs to be strengthened and supplemented by conservation tools more adapted to landscapes with strong interactions between biodiversity and human activities. Green infrastructure (GI) has better efficiency and coverage in particular because it concerns landscapes where natural and semi-natural habitats and human activity are closely intertwined. However, GI is not regulatory. Other effective area-based conservation measures (OECMs) are new conservation tools intended to complement protected areas (PAs) and might strengthen GI at local scale by sharing the common objective of restoring large scale connectivity (Convention on Biological Diversity, 2018). OECMs might be the complementary regulatory brick to PAs and GI with, in a European context, a better consideration and

recognition of management practices and certain agroecological farming practices that are more biodiversity-friendly.