

**NA2RE is reliable but aims for improvement: an answer to Vamberger and Fritz (2018)**

Neftali Sillero<sup>1</sup>, João Campos<sup>2</sup>, Anna Bonardi<sup>3,4</sup>, Claudia Corti<sup>5</sup>, Raymond Creemers<sup>6</sup>, Pierre-Andre Crochet<sup>7</sup>, Jelka Crnobrnja Isailović<sup>8,9</sup>, Mathieu Denoël<sup>10</sup>, Gentile Francesco Ficetola<sup>3,4</sup>, João Gonçalves<sup>2</sup>, Sergei Kuzmin<sup>11</sup>, Petros Lymberakis<sup>12</sup>, Philip de Pous<sup>13</sup>, Ariel Rodríguez<sup>14</sup>, Roberto Sindaco<sup>15</sup>, Jeroen Speybroeck<sup>16</sup>, Bert Toxopeus<sup>17</sup>, David R. Vieites<sup>18</sup>, Miguel Vences<sup>19</sup>

- <sup>1</sup> CICGE, Centro de Investigação em Ciências Geo-Espaciais, Observatório Astronómico Prof. Manuel de Barros, Alameda do Monte da Virgem, 4430-146 Vila Nova de Gaia, Portugal, e-mail: neftali.sillero[a]gmail.com
- <sup>2</sup> CIBIO, University of Porto, R. Campo Alegre 687, 4169-007 Porto, Portugal, e-mail: jc.campos1859[a]gmail.com, joaofgo[a]gmail.com.
- <sup>3,4</sup> Departement of Environmental Science and Policy, Università degli Studi di Milano. Via Celoria 26, 20133 Milano, Italy; Univ. Grenoble Alpes, CNRS, Laboratoire d'Écologie Alpine (LECA), F-38000 Grenoble, France, e-mail: mesophylla[a]yahoo.it, francesco.ficetola[a]gmail.com
- <sup>5</sup> Museo di Storia Naturale dell'Università di Firenze, Sezione di Zoologia "La Specola", Via Romana 17, 50125 Firenze, Italia, e-mail: claudia.corti[a]unifi.it
- <sup>6</sup> RAVON, Reptile Amphibian Fish Conservation Netherlands, P.O. Box 1413, 6501 BK Nijmegen, The Netherlands, e-mail: r.creemers[a]ravon.nl
- <sup>7</sup> CEFÉ, CNRS, University Montpellier, University Paul Valéry Montpellier 3, EPHE, IRD, Montpellier, France, e-mail: pierre-andre.crochet[a]cefe.cnrs.fr
- <sup>8</sup> Department of Biology and Ecology, Faculty of Sciences and Mathematics University of Niš, Višegradska 33, 18000 Niš, Serbia e-mail: jelka[a]pmf.ni.ac.rs
- <sup>9</sup> Department of Evolutionary Biology, Institute for Biological Research "Siniša Stanković" University of Belgrade, Despota Stefana 142, 11000 Beograd, Serbia.
- <sup>10</sup> F.R.S. - FNRS Senior Research Associate, Laboratory of Fish and Amphibian Ethology, FOCUS, Behavioural Biology Group, University of Liège, 22 Quai van Beneden, 4020 Liege, Belgium, e-mail: Mathieu.Denoel[a]uliege.be
- <sup>11</sup> Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow 117071, Russia, e-mail: ipe51[a]yahoo.com
- <sup>12</sup> Natural History Museum of Crete, University of Crete, Knossou Ave., P.O. Box 2208, 71409 Heraklion Crete, Greece, e-mail: lyberis[a]nhmc.uoc.gr
- <sup>13</sup> 1018 VN, Amsterdam, The Netherlands., e-mail: philipdepous[a]gmail.com
- <sup>14</sup> Institut für Zoologie, Stiftung Tierärztliche Hochschule Hannover, Bünteweg 17, 30559 Hannover, Germany, e-mail: eauriculatus[a]yahoo.es
- <sup>15</sup> Museo Civico di Storia Naturale, via San Francesco di Sales 88, I-10022 Carmagnola (TO), Italia, e-mail: rsindaco[a]gmail.com
- <sup>16</sup> Research Institute for Nature and Forest, Herman Teirlinckgebouw, site Thurn & Taxis, Havenlaan 88 bus 73, 1000 Brussels, Belgium, e-mail: jeroen.speybroeck[a]inbo.be
- <sup>17</sup> University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC), P.O. Box 217 7500 AA Enschede, The Netherlands, e-mail a.g.toxopeus[a]utwente.nl
- <sup>18</sup> Museo Nacional de Ciencias Naturales (MNCN), Consejo Superior de Investigaciones Científicas (CSIC). C/ José Gutierrez Abascal 2, 28006, Madrid, Spain; e-mail: vieites[a]mncn.csic.es
- <sup>19</sup> Technische Universität Braunschweig, Division of Evolutionary Biology, Zoological Institute, Mendelssohnstr. 4, 38108 Braunschweig, Germany, e-mail: m.vences[a]tu-braunschweig.de

Corresponding author: Neftalí Sillero; CICGE, Centro de Investigação em Ciências Geo-Espaciais, Observatório Astronómico Prof. Manuel de Barros, Alameda do Monte da Virgem, 4430-146 Vila Nova de Gaia, Portugal.

## Abstract

A recent paper has suggested that NA2RE, the New Atlas of Amphibians and Reptiles of Europe, does not provide a reliable basis for ecological niche modelling studies due to errors flagging introductions and missing data for the native range of the pond turtle genus *Emys*. We point out that the original NA2RE paper already acknowledged that it was not aimed for fine-scale ecological distribution modelling and that it had the objective of stimulating research for improving the maps. New works now complement the Atlas in improving the coverage and providing new distribution maps for species within species complex. Moreover, we stress that the NA2RE web platform at present hosts only the distribution data compiled in 2014 from different sources, using the taxonomy adopted by the authors at the time. As with any large database, it is advisable that these data are carefully evaluated and quality-filtered before their use in scientific studies. We defend the reliability of the NA2RE web platform as the currently most comprehensive resource for the comparative chorological study of amphibians and reptiles in Europe, and encourage publication of updates and additions following the most recent taxonomic changes, to continuously improve this database and the Atlas.

**Keywords** Chorological data, ecological niche modelling, herpetological database, citizen data, online atlas

NA2RE is the online-distributed database system (Sillero et al. 2014a) hosting the data presented in the New Atlas of Amphibians and Reptiles in Europe (Sillero et al. 2014b) – hereafter the Atlas. Both contributions – the Atlas and the database – were published in the same year to provide an overview on the geographic distribution of 211 taxa (species and species-complexes) in Europe. This collaborative effort was conceived to highlight gaps in species distribution ranges, while acknowledging the need for continuous updating to include new taxonomic changes and novel occurrence records. In some cases involving species complexes where many records were not reliably assignable at the species level, we deliberately decided to produce maps merging all records for the entire complex. On the basis of the analysis of the distribution of the genus *Emys*, Vamberger and Fritz (2018) have recently recommended not to use the online version (the NA2RE platform) of the Atlas for ecological niche modelling because of errors in flagging occurrence records referring to introduced populations, and because of missing data within the native range in the genus *Emys*. Moreover, for *Emys orbicularis* (Linnaeus, 1758), they also criticized that *E. orbicularis* was treated as a single species and that consequently no distinct maps were provided for *E. orbicularis* and *E. trinacris* Fritz, Fattizzo, Guicking, Tripepi, Pennisi, Lenk, Joger & Wink, 2005. We hereby reply to their comments.

The NA2RE web platform (Sillero et al. 2014a) only hosts the data compiled in 2014 for the Atlas (Sillero et al. 2014b), following the taxonomy adopted by the *Societas Europaea Herpetologica* Mapping Committee and modified from Speybroeck et al. (2010). Any atlas project is immediately outdated the day after publication. Indeed, the NA2RE platform was created with the aim to be a permanently updated system, and NA2RE is still under development to integrate more detailed and recent data from local to global databases in a fully distributed system. The Atlas and the NA2RE platform mainly integrate published data, such as national atlas publications and websites, personal data kindly provided to the SEH (when national databases were not available), the 1997 European Atlas (Gasc et al. 1997), and the Global Biodiversity Information Facility (GBIF). Species maps highlight cells where only GBIF data or those from the 1997 atlas were

available. When the NA2RE online platform will be updated, it will be made clear that it differs from the published Atlas. We herein reaffirm the reliability of the Atlas and the NA2RE platform for the purpose to which it was built as described by Sillero et al. (2014a).

As with any biological data, all range maps have some measurement error (Rocchini et al. 2011; Ficetola et al. 2014). Producing the best distribution data requires continuous updates, both because our knowledge of species distribution and diversity continuously update, and because species ranges are not static, but can undergo fast modifications in response to global changes. Even if the sizeable author consortium corrected the data to the best of their ability, any chorological project suffers from errors. Vamberger and Fritz (2018) suggest that "a group of specialists should review the maps before publication for assuring data quality". In fact, all current maps have been carefully reviewed by a group of herpetologists before producing the published maps, and then entered in the NA2RE platform. At the moment of publication, the database included >380,000 species records spread over all the European countries, and it is obvious that revising such "big data" is a herculean task. Even though NA2RE contains missing and mislabelled data, as acknowledged in the original publication of the Atlas (Sillero et al. 2014b), this project is the largest validated collection of herpetofauna distribution data for Europe, and no better or more comprehensive data are available for all species together. Unfortunately, many of the errors indicated by Vamberger and Fritz (2018) are also present in the sources and therefore are difficult to be identified. Furthermore, Kleewein (2016) and Raemy et al. (2017), cited by Vamberger & Fritz (2018), cannot be considered as previous reviews to the Atlas, as these works were published three years after the Atlas. We stress again that for now, the NA2RE platform only presents the data compiled in the Atlas and thus presents the knowledge on European species distribution available through the included databases up to the end of 2013 when the manuscript was accepted for publication. Therefore, the NA2RE platform and the Atlas ignored any distribution data published before the end of 2013 that were not included in national databases. Future mapping projects, either restricted to a certain number of taxa or in the framework of a full revision of European chorology will need to be included as updates, as already stated in the Atlas. However, the way of including these new updates is not through the NA2RE platform. Distribution updates must be incorporated in the national databases, and then, these updates will become visible in the NA2RE system. We would like to stress that the NA2RE platform is a distributed system of databases (local clients), where the responsibility of the data belongs exclusively to the owners of those databases, not to the administrators of NA2RE. Large gaps remain in NA2RE for many regions in Europe, such as the Balkan countries, but recent publications for Albania (Mizsei et al. 2017; Szabolcz et al. 2017) and a new mapping initiative for the entire Balkans will surely result in important updates to the database. Fortunately, as stated before, the NA2RE platform will allow the incorporation of updated data from the local clients shortly. As such, it is our vision that finding flaws such as those listed by Vamberger and Fritz (2018) on one species (or two, per their view on *Emys* taxonomy) should lead to concerted improvement of NA2RE platform.

Vamberger and Fritz (2018) also criticized the fact that some presence points of the Atlas are non-native populations. In Europe, humans have performed translocations of amphibians and reptiles for centuries, and there are many species and populations for which the status (native/non-native) has been debated for decades. For instance, suspicions exist that substantial parts of the Balearic herpetofauna have been historically introduced in Roman times (Pinya and Carretero, 2011) but solid evidence is lacking for many species, as in similar cases on other Mediterranean islands. Prematurely flagging such populations as introduced could in extreme cases lead to

eradication programs and thus should be done with extreme care. Therefore, identifying the introduced vs. native status of populations was beyond of the aims of the Atlas (as specified in Sillero et al. 2014b: “*Besides native species and populations, a number of national data sets also included introductions, i.e. introduced species from outside Europe as well as introduced populations of European species occurring outside their natural range. In this case, our compilation is not fully consistent*”), except in a few very obvious cases. However, the presence of non-native records does not undermine the usefulness of the Atlas data for ecological analyses. In fact, the combination of native and non-native presence records allows a better description of the niche of the species. Thus, several studies advocated the integration of native and non-native presence records to improve the predictive performance of species distribution models (Jiménez-Valverde et al. 2011). Future updates of the Atlas and NA2RE platform will correct the status of some introduced/native populations when new data are available.

Herpetological European taxonomy has changed dramatically in the last decade, with new species being discovered and new taxa described, sometimes as the result of splitting species complexes. This prompts the need to better delineating the ranges of the taxa affected by taxonomic changes in Europe, and it is one of the aims of the Atlas to encourage researchers to contribute to this endeavour. However, because such updates were lacking for many species complexes, mapping them together in a single map was an intentional choice, pending insight to be gained. As a consequence, positive follow-up of the release of the new Atlas promoted several updates in the distribution of some groups of species, in order to correct or improve their distribution maps. For example, new maps have been published for the crested and marbled newt species *Triturus* (Wielstra et al. 2014), the smooth newt species complex *Lissotriton* (Wielstra et al. 2018), and the meadow and steppe vipers of genus *Vipera* (Mizsei et al. 2018). Therefore, a similar update could have been done for *E. orbicularis* and *E. trinacris* to delineate their respective distribution ranges. However, Vamberger and Fritz (2018) simply dispose of Sillero et al.’s (2014b) taxonomy as being outdated because it was supposedly based on the outdated understanding of *Emys* taxonomy of Speybroeck et al. (2010). We want to make clear that NA2RE is using the available taxonomy in order to map distribution ranges, but it is out of its scope to make taxonomic decisions if the taxonomy is not accepted by all authors. The taxonomy used in the NA2RE project was taken from Speybroeck et al (2010), as reported in Sillero et al. (2014); *E. trinacris* was not included because of a lack of consensus on the validity of its specific rank within the SEH Taxonomic Committee at the time. Indeed, we would also like to point out the current lack of unanimous support for the specific rank of *E. trinacris* among the authors of this paper. Hence, we regret that Vamberger & Fritz (2018) do not limit their critique to the mapping aspects of the Atlas project. Therefore, a similar update must be done for *E. orbicularis* and *E. trinacris* to delineate their respective distribution ranges. If and when the taxonomy of European amphibians and reptiles is updated, users will be able to easily modify in a GIS environment the species data provided by the Atlas to address any taxonomic revision.

We also wish to reiterate that the restrictions and gaps of the Atlas and the associated NA2RE database were explicitly mentioned by ourselves (Sillero et al., 2014b) and the criticism of Vamberger and Fritz (2018) is therefore somewhat pointless. For instance, we stated (Sillero et al. 2014b): “*Introduction records were defined using our current knowledge, which is not homogeneous, thus bias may be present for some species and regions.*” --- “*The coarse 50 × 50 km occurrence data were not suitable for sophisticated analyses (e.g. calculation of ecological niche models), and these were not the main goal of this compilation.*” --- “*... the data presented here*

*provide a first, tentative step...*" --- "*... we call for concerted and varied efforts to fill the geographic and taxonomic gaps identified.*" In fact, about two entire pages in Sillero et al. (2014b) are devoted to stress the taxonomic and geographic gaps of knowledge inherent in our compilation. It is thus obvious that the NA2RE database was never produced as a ready-to-use resource for species distribution modelling. However, other analyses can be done, such as the biogeographical analyses included in Sillero et al. (2014b). In fact, we wish to stress that no such resource currently exist for European amphibians and reptiles. Any study using presence data for distribution modelling or any other purpose will first need to perform an extensive step on data curation to identify and remove erroneous or suspicious presence data, flag records of introduced populations or translocated individuals, and to identify areas where the lack of records contradicts knowledge on species' distributions.

Large distribution databases do not pretend to be perfect but continuously updated to correct errors and incorporate novel data. In fact, even coarse distribution data (e.g. IUCN maps, GBIF data) can provide very useful information, if the users employ them at the appropriate resolution, acknowledge their inherent uncertainty, and take into account the biology of target species (van Wilgen et al. 2009; Maldonado et al. 2015). The resolution and the accuracy of the Atlas surpass most of broad-scale available datasets (Ficetola et al. 2014). Therefore, we expect that studies using the Atlas data will provide better results compared to work performed with other resources. Given its current resolution (50 x 50 km), the Atlas is not intended for fine-scale ecological modelling as it stands, as detailed locality data should be used for this. 50x50km grids do not represent habitat variability properly and misdirected conclusions from ecological niche models (Sillero 2011) might lead to wrong conservation actions. In contrast, the Atlas makes it possible to present distribution ranges based on datasets rather than approximate contours, which should give a more precise delineation of species ranges. More detailed geographical scales and support from taxon specialists are therefore much appreciated and necessary. The recent works by Wielstra et al. (2017, 2018) and Mizsei et al. (2018) are excellent examples of improvements of distribution maps triggered by the Atlas initiative.

## **Acknowledgements**

The authors thank the *Societas Europaea Herpetologica* for funding the NA2RE project. NS is supported by an IF contract (IF/01526/2013) from Fundação para a Ciência e a Tecnologia (Portugal).

**Conflict of interest** The authors declare that they have no conflict of interest.

## **References**

- Battisti C, Luiselli L (2011) Selecting focal species in ecological network planning following an expert-based approach: Italian reptiles as a case study. *J Nat Conserv* 19: 126-130. <https://doi.org/10.1016/j.jnc.2010.10.001>
- Carretero, M.A., Pinya, S. (2011): The Balearic herpetofauna: a species update and a review on the evidence. *Acta Herpetol* 6: 59-80. [http://dx.doi.org/10.13128/Acta\\_Herpetol-9579](http://dx.doi.org/10.13128/Acta_Herpetol-9579)

- Ficetola GF, Salvidio S, D'Angelo S, Bonardi A, Bottoni L, Canalis L, Crosetto S, Di Martino S, Ferri V, Filetto P, Genta P.; Jesu R, Masin S, Mazzotti S, Ottonello D, Richard J, Sala L, Scali S, Tedaldi G, Vianello F (2013) Conservation activities for European and Sicilian pond turtles (*Emys orbicularis* and *Emys trinacris*, respectively) in Italy. *Herp Notes* 6: 127-133.
- Ficetola GF, Rondinini C, Bonardi A, Katariya V, Padoa-Schioppa E, Angulo A (2014) An evaluation of the robustness of global amphibian range maps. *J Biogeogr* 41: 211-221. <https://doi.org/10.1111/jbi.12206>
- Fritz U, d'Angelo S, Pennisi MG, Lo Valvo M (2006) Variation of Sicilian pond turtles, *Emys trinacris* – What makes a species cryptic? *Amphibia-Reptilia* 27: 513-529. <https://doi.org/10.1163/156853806778877095>
- Fritz U, Guicking D, Kami H, Arakelyan M, Auer M, Ayaz D, Fernández CA, Bakiev AG, Celani A, Dzukic G, Fahd S, Havas P, Joger U, Khabibullin VF, Mazanaeva LF, Siroky P, Tripepi S, Vélez A, Velo Antón G, Wink M (2007) Mitochondrial phylogeography of European pond turtles (*Emys orbicularis*, *Emys trinacris*) – an update. *Amphibia-Reptilia* 28: 418-426. <https://doi.org/10.1163/156853807781374737>
- Gasc JP, Cabela A, Crnobrnja-Isailovic J, Dolmen D, Grossenbacher K, Haffner P, Lescure J, Martens H, Martínez Rica JP, Maurin H, Oliveira ME, Sofianidou TS, Veith M, Zuiderwijk A (1997) Atlas of amphibians and reptiles in Europe. Collection Patrimoines Naturels 29, Societas Europaea Herpetologica and Muséum National d'Histoire Naturelle, Paris.
- Jiménez-Valverde A, Peterson AT, Soberon J, Overton JM, Aragon P, Lobo JM (2011) Use of niche models in invasive species risk assessments. *Biol Invas* 13: 2785-2797. <https://doi.org/10.1007/s10530-011-9963-4>
- Kleewein A (2016) First genetic investigation into the occurrence of *Emys orbicularis* (Linnaeus, 1758) in Carinthia, Austria. *Herpetozoa* 29: 90-92.
- Maldonado C, Molina CI, Zizka A, Persson C, Taylor CM, Albán J, Chilquillo E, Rønsted N, Antonelli A (2015) Estimating species diversity and distribution in the era of Big Data: to what extent can we trust public databases? *Glob Ecol Biogeogr* 24: 973-984. <https://doi.org/10.1111/geb.12326>
- Mizsei E, Jablonski D, Végvári Z, Lengyel S, Szabolcs M (2017) Distribution and diversity of reptiles in Albania: a novel database from a Mediterranean hotspot. *Amphibia-Reptilia* 38: 157-173. <https://doi.org/10.1163/15685381-00003097>
- Mizsei E, Zinenko O, Sillero N, Ferri V, Roussos SA, Szabolcs M (2018): The distribution of meadow and steppe vipers (*Vipera graeca*, *V. renardi* and *V. ursinii*): a revision of the New Atlas of Amphibians and Reptiles of Europe. *Bas Appl Herpetol* 32. <http://dx.doi.org/10.11160/bah.94>.
- Raemy M, Fritz U, Cheylan M, Ursenbacher S (2017) Hybridisation between turtle subspecies: a case study with the European pond turtle (*Emys orbicularis*). *Conserv Gen* 18: 287-296. <https://doi.org/10.1007/s10592-016-0901-y>

- Rocchini D, Hortal J, Lengyel S, Lobo JM, Jimenez-Valverde A, Ricotta C, Bacaro G, Chiarucci A (2011) Accounting for uncertainty when mapping species distributions: The need for maps of ignorance. *Prog Phys Geogr* 35: 211-226. <https://doi.org/10.1177/0309133311399491>
- Sillero N (2011) What does ecological modelling model? A proposed classification of ecological niche models based on their underlying methods. *Ecol Mod* 222: 1343-1346. <https://doi.org/10.1016/j.ecolmodel.2011.01.018>
- Sillero N, Bonardi A, Campos J, Corti C, Creemers R, Crnobrnja-Isailović J, Crochet P, Denoël M, Ficetola G.F, Gonçalves J., Kuzmin S, Lymberakis P, De Pous P, Sindaco R, Speybroeck J, Toxopeus B, Vieites DR, Vences M (2014b) Updated distribution and biogeography of amphibians and reptiles of Europe. *Amphibia-Reptilia* 35: 1-31. <https://doi.org/10.1163/15685381-00002935>
- Sillero N, Oliveira MA, Sousa P, Sousa F, Gonçalves-Seco L (2014a) Distributed database system of the New Atlas of Amphibians and Reptiles in Europe: the NA2RE project. *Amphibia-Reptilia* 35: 33-39. <https://doi.org/10.1163/15685381-00002936>
- Speybroeck J, Beukema W, Crochet PA (2010) A tentative species list of the European herpetofauna (Amphibia and Reptilia) – an update. *Zootaxa* 2492: 1-27.
- Speybroeck J, Crochet PA (2007) Species list of the European herpetofauna – a tentative update. *Podarcis* 8: 8-34.
- Szabolcs M, Mizsei E, Jablonski D, Vági B, Mester B, Végvári Z, Lengyel S (2017) Distribution and diversity of amphibians in Albania: new data and foundations of a comprehensive database. *Amphibia-Reptilia* 38: 435-448. <https://doi.org/10.1163/15685381-00003126>
- Vamberger M, Fritz, U (2018) Big data can cause big mistakes: using the *Societas Europaea Herpetologica* atlas by Sillero et al (2014), the distribution of *Emys orbicularis* will be misunderstood. *Biologia*: 73: 281-283. <https://doi.org/10.2478/s11756-018-0033-6>
- van Wilgen NJ, Roura-Pascual N, Richardson DM (2009) A quantitative climate-match score for risk-assessment screening of reptile and amphibian introductions. *Environ Manag* 44: 590-607. <https://doi.org/10.1007/s00267-009-9311-y>
- Wielstra B, Canestrelli D, Cvijanović M, Denoël M, Fijarczyk A, Jablonski D, Liana M, Naumov B, Olgun K, Pabijan M, Pezzarossa A, Popgeorgiev G, Salvi D, Si Y, Sillero N, Sotiropoulos K, Zieliński P, Babik W (2018) The distributions of the six species constituting the smooth newt species complex (*Lissotriton vulgaris* sensu lato and *L. montandoni*) – an addition to the New Atlas of Amphibians and Reptiles of Europe. *Amphibia-Reptilia* 39: 252-259. <https://doi.org/10.1163/15685381-17000128>
- Wielstra B, Sillero N, Vörös J, Arntzen JW (2014) The distribution of the crested and marbled newt species (Amphibia: Salamandridae: *Triturus*) – an addition to the New Atlas of Amphibians and Reptiles of Europe. *Amphibia-Reptilia* 35: 376-381. <https://doi.org/10.1163/15685381-00002960>