Priority areas for biodiversity conservation in the context of global change

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INTRODUCTION

Human-driven habitat degradation, climate change and biological invasions are major causes of current species mass extinction. In Europe where wetland surface area has declined by 90% since 1700s, **the European pond turtle *Emys orbicularis* is considered as the reptile that suffered the most dramatic decline**. Recently alien turtle species originated from America, Asia and Africa have been widely spread in Europe with high invasion potential threatening native biodiversity. In this study, we performed **species distribution models and GIS modeling** for the native European pond turtle and 7 of the most frequently recorded exotic freshwater turtles representative of invasive species throughout the range of the European pond turtle, in order to identify the most relevant priority areas for native biodiversity conservation in the context of global change.


E. orbicularis caught in Ukraine


T. scripta caught in Ukraine


P. concinna recorded in Latvia


P. nelsoni recorded in Latvia


P. sinensis caught in Latvia


M. caspica caught in


M. rivulata caught in Latvia

MATERIALS & METHODS

Databases were created for the European pond turtle, and for 7 species originated from North America (the red-eared pond slider *Trachemys scripta*, the river cooter *Pseudemys concinna,* the Florida red-bellied cooter *Pseudemys nelsoni* and *Graptemys pseudogeographica*, from Asia (the Chinese soft-shell turtle *Pelodiscus sinensis*) and from middle East (the Caspian turtle *Mauremys caspica* and the Balkan terrapin *Mauremys rivulata*), using available points of registration of the target species using data published in literature, GBIF dataset and original field records.

Using **Species Distribution Models** based on CliMond climate dataset, and NGEI for freshwater ecosystems, we determined probabilistic models of distribution for the 8 species. We identified the major environmental drivers of species-specific distribution and potential overlaps for identifying priority areas for future conservation initiatives.

GIS modeling was used to explore the potential distribution of each species, using Maxent v3.3.3 software with 25 replicates (Phillips 2005), 35 Bioclim variables and 5 bioclimatic covariates (CliMond; Kriticos et al. 2014; https://www.climond.org/ accessed 27 December 2020).

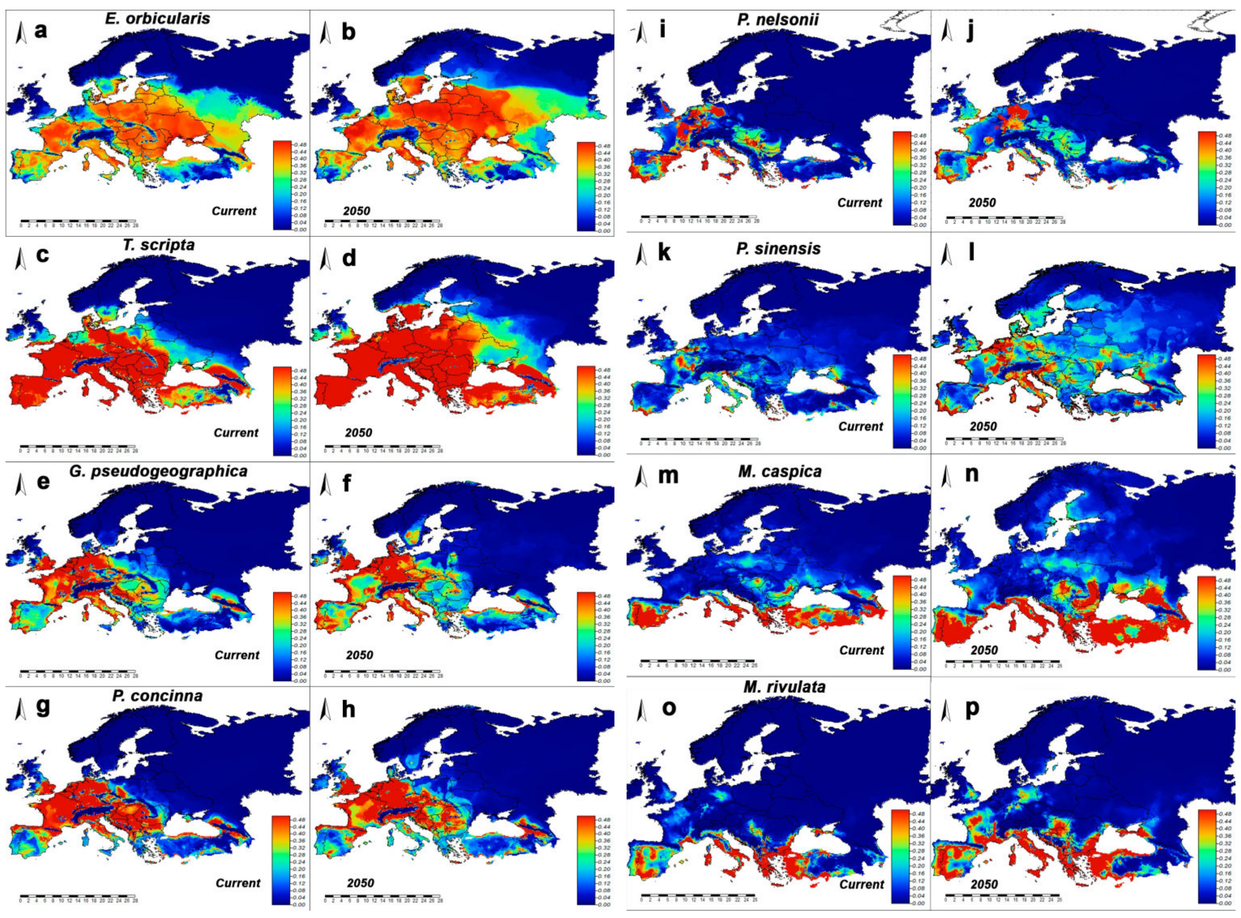

Fig 2. Potential (probabilistic) distribution model of: *E. orbicularis* (a - current; b - 2050); *T. scripta* (c - current; d - 2050); *G. pseudogeographica* (e - current; f - 2050); *P. concinna* (g - current; h - 2050); *P. nelsonii* (i - current; j - 2050); *P. sinensis* (k - current; l - 2050); *M. caspica* (m - current; n - 2050); *M. rivulata* (o - current; p - 2050).

We conclude that priority conservation areas for the endangered European pond turtle are Eastern and Northern Europe, where future competition risks of invasive turtles are limited (Fig 3D).

RESULTS

Our models of present distributions of the 8 turtle species show that currently *T. scripta* and *G. pseudogeographica* share similar distributional drivers as the European pond turtle (**Fig 1**). These two exotic species exhibit highest ecological flexibility, occupying most habitats suitable for native *E. orbicularis* with ~45% overlap at the scale of (mainly Western) Europe (**Fig 2**). **By 2050**, this overlap will increase (**Fig 2**), except in Northern and Eastern Europe where *E. orbicularis* is predicted to expand its range by 700 km, while exotic turtles spread only up to Southwestern Ukraine (**Fig 3**).

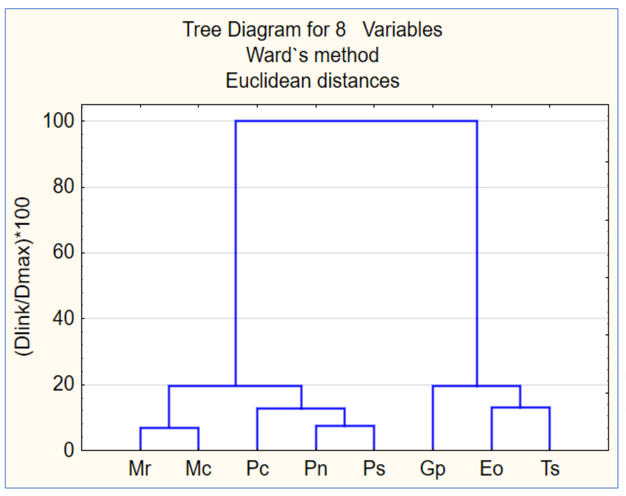

Fig 1. Results of cluster analysis with the use of distributional data: Mc – *M. capsica*, Mr – *M. rivulata*, Pc – *P. concinna*, Pn – *P. nelsonii*, Ps – *P. sinensis*, Gp - *G. pseudogeographica*, Eo - *E. orbicularis*, Ts – *T. scripta*.

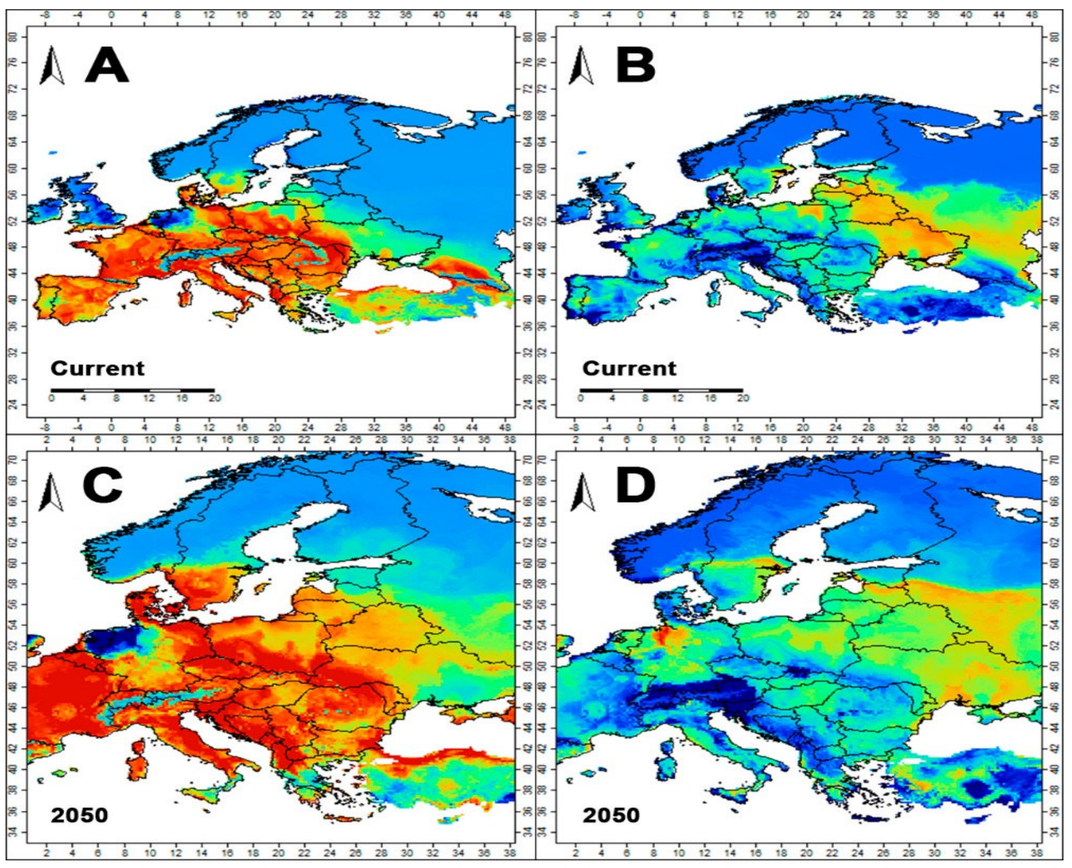

Fig 3. Based on Multiple Regression Analysis, models outcomes for: A - area of intersection of current promising habitats for the native European pond turtle *E. orbicularis* and 7 exotic turtle species; B - area of current promising habitat for *E. orbicularis*, without 7 species of invasive aquatic turtles; C - area of intersection of further promising habitats (to 2050) of all 8 species of turtles; D - area of further promising habitats (to 2050) for *E. orbicularis*, without 7 species of invasive aquatic turtles.

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