Constant responsibility for species conservation inspite of variable projections of future range under climate change - The example of the Green Hawker (*Aeshna viridis*)

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Part of an R&D-Project „Impacts of climate change on fauna, flora and habitats of the NATURA 2000 system and adaptation strategies of nature conservation. FKZ 3508 85 0600 UFOPLAN 2008; for: Federal agency for nature conservation, Bonn.
In cooperation with Chair of Biogeography, University of Bayreuth, Germany. 2008-2011.

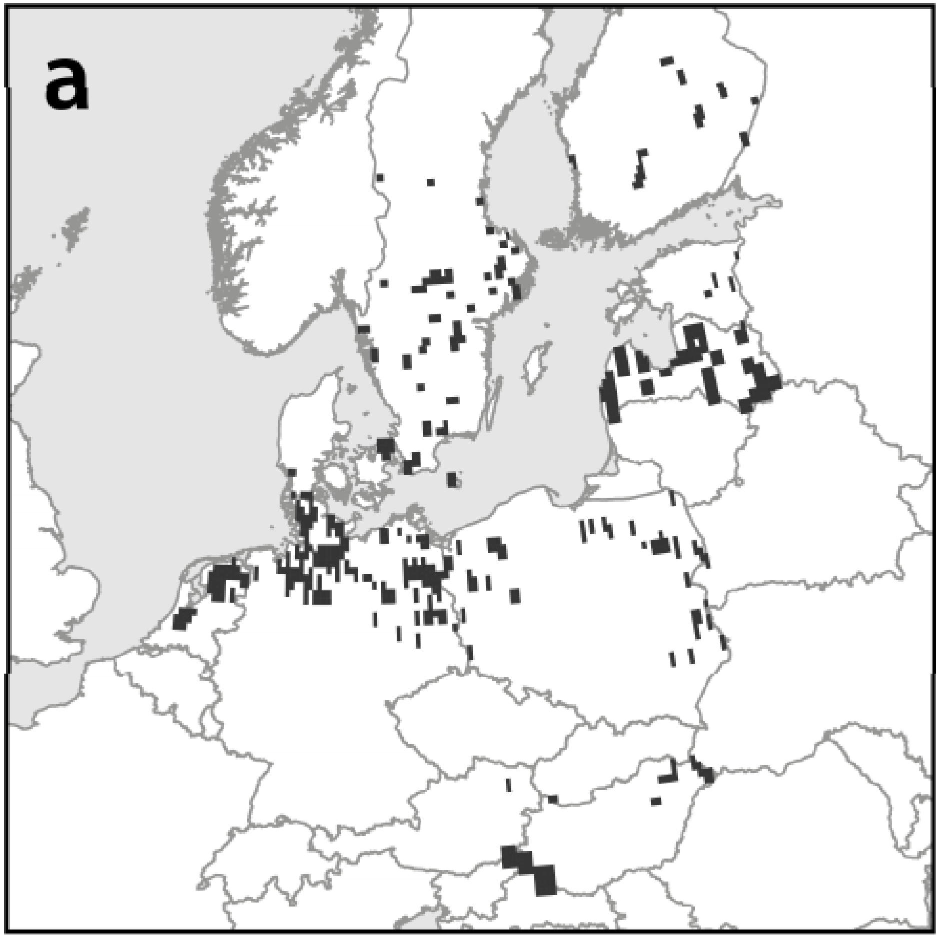
Introduction

- Biotic interactions are rarely incorporated in species distribution models (climate envelope technique for projecting future ranges under climate change)
- The importance of interactions for climate change risk assessments is increasingly acknowledged
- Climate change is expected to alter biotic interactions, including potential temporal and spatial mismatches of interacting species
- The green hawker (*Aeshna viridis*) and its oviposition plant, the water soldier (*Stratiotes aloides*) are used as an example.

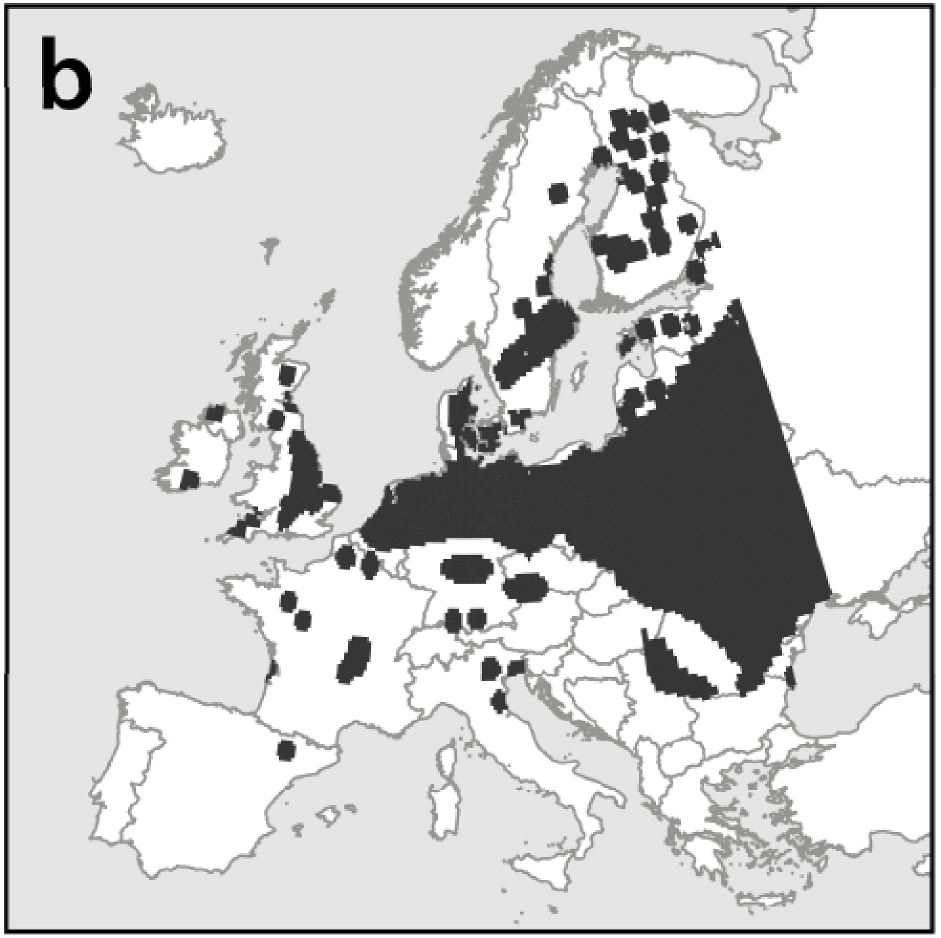
Aim: to compare different modelling techniques (with and without regarding the interaction) and to assess the different projected ranges under climate change

Method: We compared 3 different approaches for incorporating biotic interactions in species distribution models

Green Hawker



Water soldier



Distribution of (a) *Aeshna viridis* and (b) *Stratiotes aloides* in Europe.
Source: *A. viridis*: (EIONET 2009), *S. aloides* (Hultén and Fries 1986).

Methods of species distribution modelling

One model with 9 different algorithms, programme BIOMOD

The following explanatory variables were used in species distribution modelling:

- mean monthly precipitation during the activity period of the adult dragonfly (May - August, mm),
- precipitation sum in the vegetation period (March-September, mm),
- sum of equilibrium evapotranspiration in the vegetation period (March-September, mm),
- maximum temperature of the warmest month of the year,
- minimum temperature of the coldest month of the year (°C) and
- the current and potential future occurrence probabilities of *Stratiotes aloides* in Europe.

3+1 approaches:

a) Base modelling: only climatic variables, no interactions

b) We separately modelled the potential future distributions of each species based on climatic information, and intersected the future range overlap (‘overlap approach’, under a no dispersal restriction assumption).

c) We modelled the potential future distribution of *A. viridis* with the projected occurrence probability of *S. aloides* as further explanatory variable in addition to climatic variables (‘explanatory variable approach’, under a no dispersal restriction assumption).

d) We calibrated the climate envelope model of *A. viridis* in the current range of *S. aloides*, projected its distribution on Europe and multiplied the future occurrence probabilities of both species (‘reference area approach’). The model is based only on climatic information from the current range of *S. aloides*.

Results

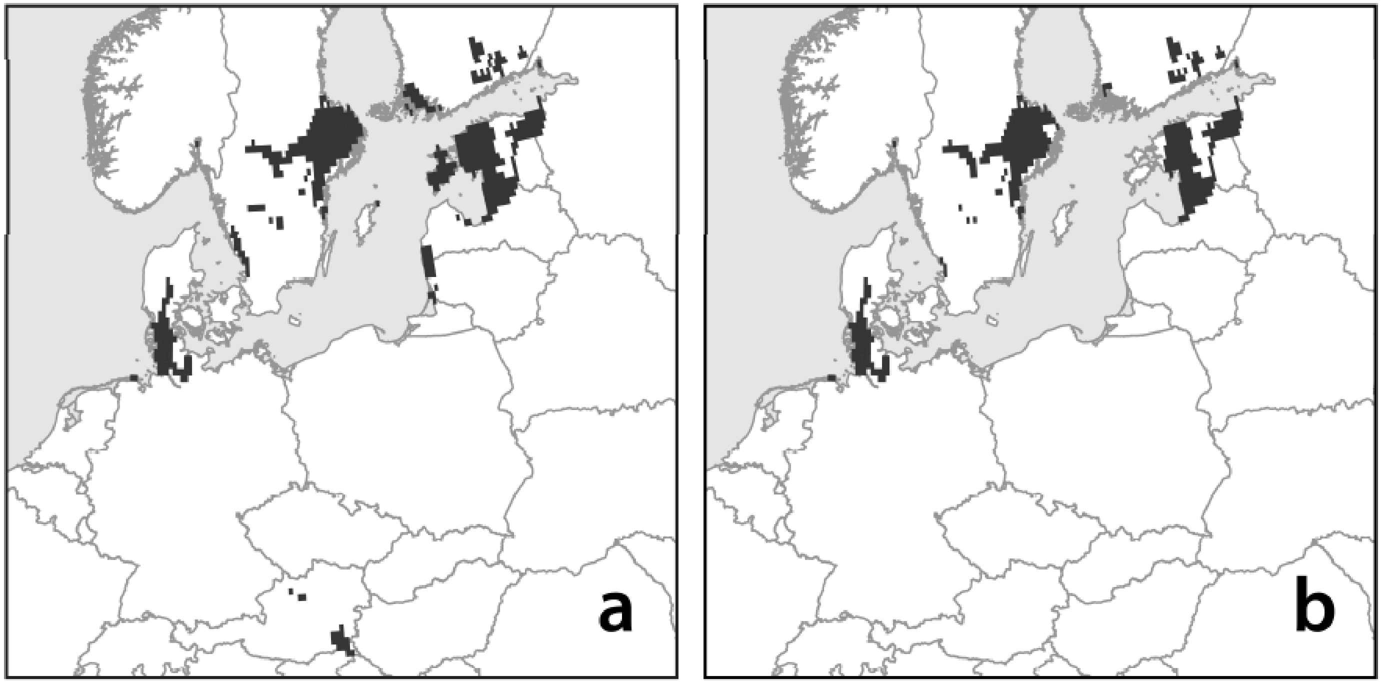
Projected range contraction and range expansions depend on the model (a, b, c, d):

a: range contraction of A. viridis (-11%) (assuming unlimited dispersal ability)

b: strong range contraction (-32%)
c: similar to b): range contraction in the south, to a smaller extent (- 20%)
d: range contraction in the south, between b) and c) (- 29%)

Spatial changes:
No spatial gap of the ranges of the dragonfly and its oviposition plant, but a similar change in the same direction.

No northward shift of range limits, but range contraction by losses in the south <u>and</u> in the north of the european range.



Only climatic parameters | „overlap“ approach

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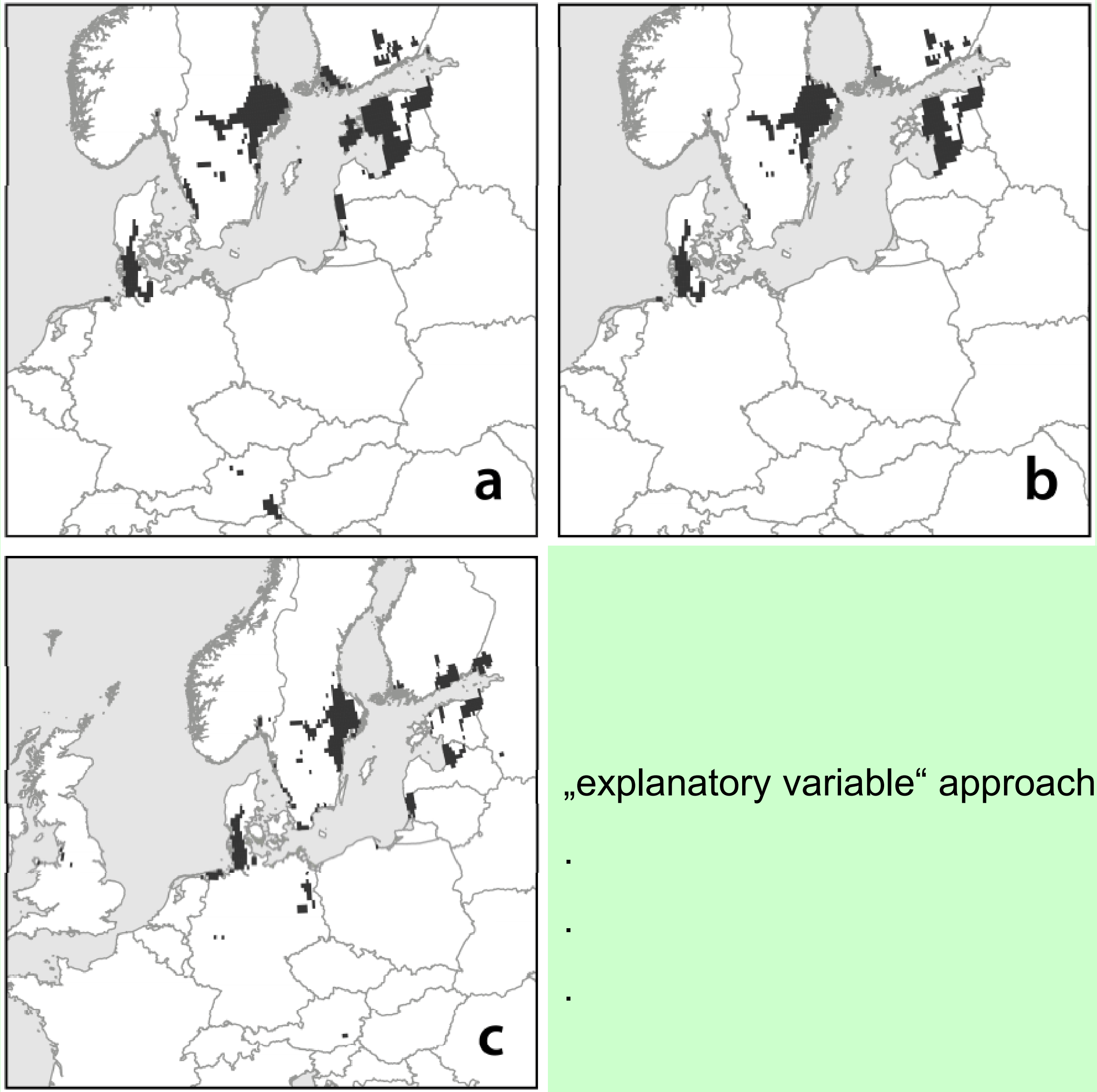

„explanatory variable“ approach

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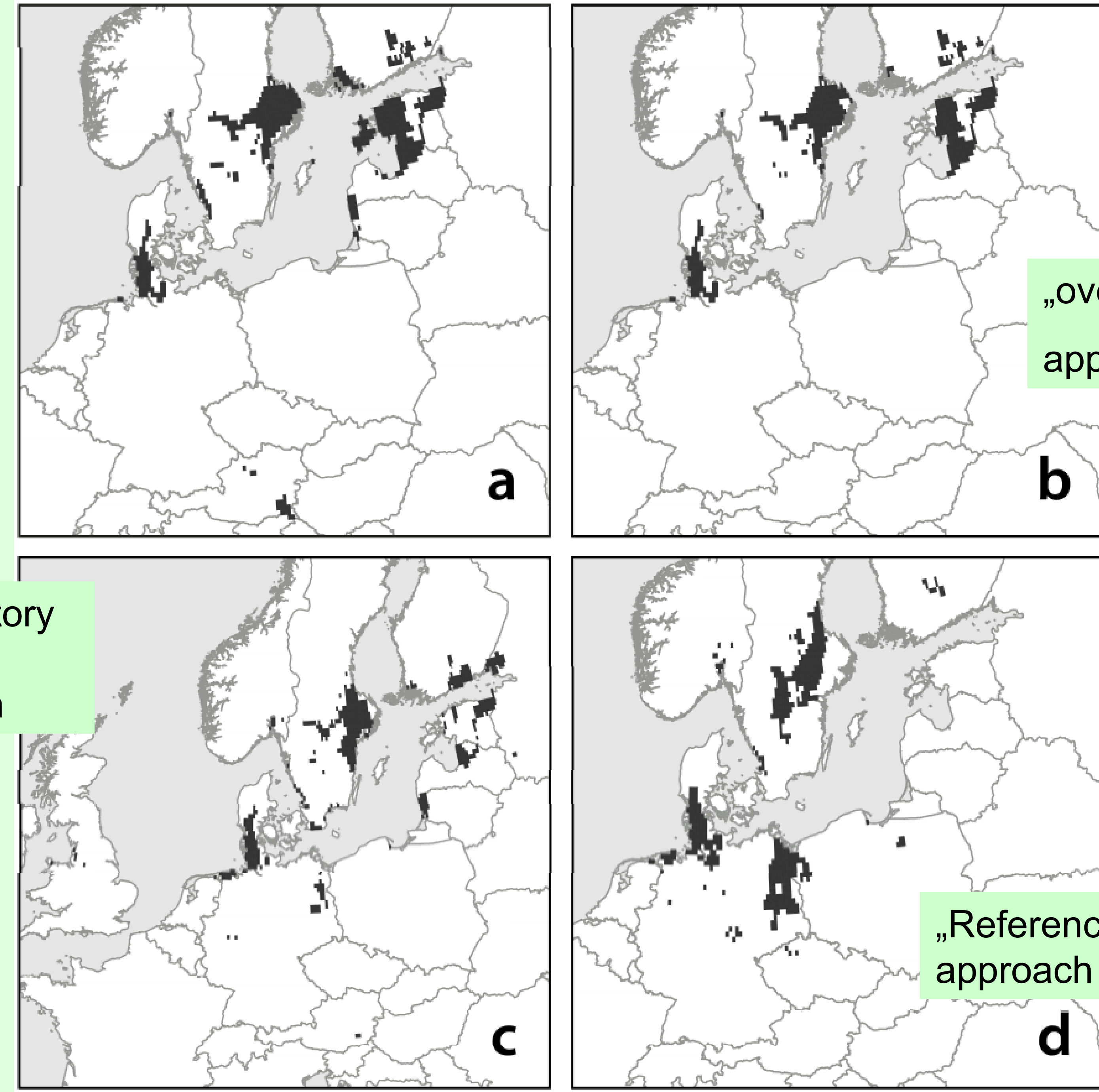
Base model

Only climate



„overlap“ approach

„explanatory variable“ approach

„Reference area“ approach

All models show range contraction:

Projections show range contraction in the south and no or small range expansion in the north, in contrast to current knowledge fo range expansion into the European north (e.g. Hickling et al. 2005, or Hassall and Thompson 2008; Ott 1996 ff. etc.). This feature depends on the thresholds for occurrence probabilities.

Comparison with and without interactions:

Strong differences to the model which uses only climatic parameters (base approach, type a).

Consequences for nature conservation

Different modelling techniques reveal different distribution maps (at the same emission szenario A2, GCM Global-Model HadCM3, 2021-2050).

Range contraction and range expansion are distributed in different countries.

Germany remains responsible for the conservation of *A. viridis* in Europe (2 models) or gets the main responsibility for this species in Europe (1 model).

The conditions for *A. viridis* should therefore here in Germany be optimized and enhanced so that this species can be dropped out of the Red List.

The species should get a favorable condition in the continental biogeographic region (according to the Habitats Directive).

Consequences for nature conservation

Increase of populations = the central target

Finishing the unfavorable or bad conditions now

Gaining a favorable condition in the near future (protecting habitats, targeted measures for enhancing populations)

e.g. optimizing and rewetting of wetlands, backwaters

Getting the species fit for climate change

Climate change leads to more nature conservation, not less.

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