



Mapping the potential distribution of the invasive apple snails (*Pomacea canaliculata* and *P. maculata*) in European wetlands and freshwater ecosystems

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Aim of the study

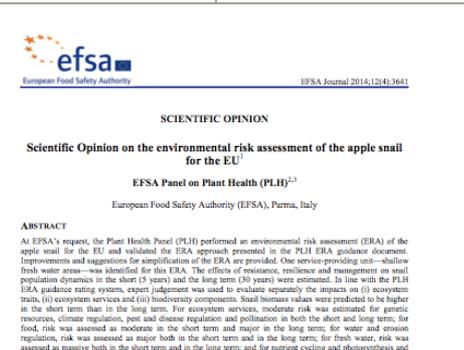
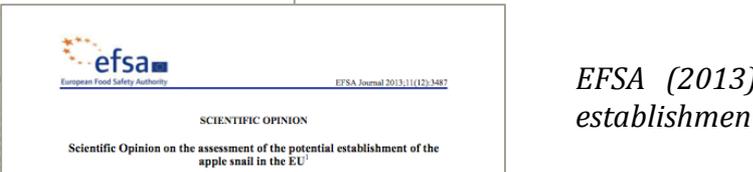
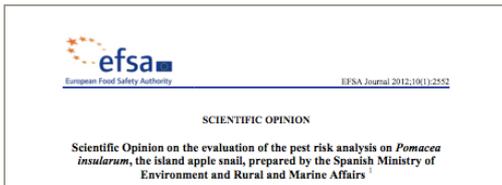
- Two main goals:
 - 1) Specific: mapping the potential distribution of the invasive apple snails (*Pomacea canaliculata* and *P. maculata*) in European wetlands and freshwater ecosystems
 - 2) General: to show a methodological framework (i) able to define the area of potential establishment on the basis of the physiologically-based approach to population dynamics modelling (ii) that uses the population abundance (whatever defined) as the driver that can better explain the impact (iii) that links the area of potential establishment with the suitable habitats (iv) that makes possible, if available, the implementation of models linking the population abundance with the impact on cultivated plants and/or the environment

Pest Risk Analysis

EFSA (2012). Scientific Opinion on the evaluation of the pest risk analysis on Pomacea insularum, the island apple snail, prepared by the Spanish Ministry of Environment and Rural and Marine Affairs.

EFSA (2013). Scientific Opinion on the assessment of the potential establishment of the apple snail in the EU.

EFSA (2014). Scientific Opinion on the environmental risk assessment of the apple snail for the EU.



Pest Risk Analysis

 **EFSA Journal** 2012;10(1):2552

SCIENTIFIC OPINION

Scientific Opinion on the evaluation of the pest risk analysis on *Pomacea insularum*, the island apple snail, prepared by the Spanish Ministry of Environment and Rural and Marine Affairs

EFSA Panel on Plant Health
European Food Safety Authority

ABSTRACT

The Panel considers the Spanish pest risk evidence. However, (i) the environmental potentially endangered area are too limited climatic conditions, that are very similar to suitable host plants are available. The Panel the risk assessment area (ii) the potential probability for establishment of the organism likely. The Panel disagrees with the Spanish environment to be massive under suitable 4 entry of the organism to be high. Regarding to single risk reduction method is sufficient. PRA area. However, a legislative ban on import can reduce the probability of entry. The probability of spread within the PRA area, *casualis* complex, as *Pomacea insularum* are almost indistinguishable. This is of part and trade of the organism.

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 **EFSA Journal** 2013;11(12):3487

SCIENTIFIC OPINION

Scientific Opinion on the assessment of the potential establishment of the apple snail in the EU¹

EFSA Panel on Plant Health
European Food Safety Authority

This Scientific Opinion, published on 12 March 2014

2013.*

ABSTRACT

EFSA requested the PLH Panel to review the current s reported in this opinion, and to perform an environment assessment document, which will be provided the current state of the art of the biology of apple snail assess the potential establishment of apple snails in the *Pomacea conspurcator* and *P. manilata* were perfect characteristics related to temperature, which was used on the systematics and taxonomy of the genus *Pomacea* is a synonym of *P. manilata* and can be spread occurs via rivers and canals, in which the snails addition, attachment to animals (e.g. birds, cattle, bo Human assistance results in spread through cultivation and agricultural field machinery. The potential diet calculating with the population dynamics model, the 0.25 × 0.25 degrees covering Europe, which resulted establishment comprises wetlands of southern Europe (the Balkans up to the latitude of the Danube river, 6 production areas in Europe.

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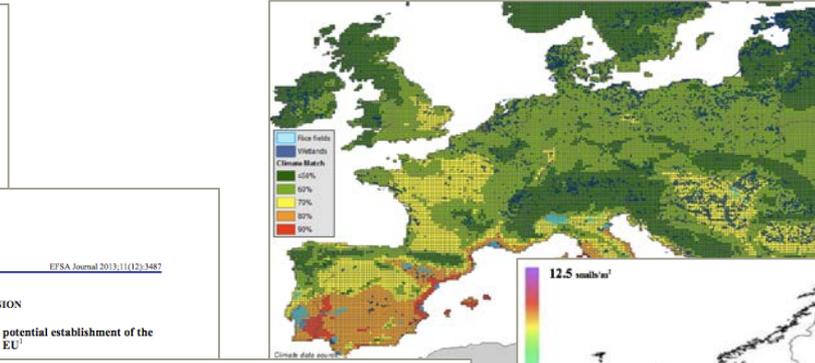
KEY WORDS

apple snail, *Pomacea insularum*, *Pomacea conspurcator*

ABSTRACT

On request from EFSA, Question No EFSA-Q-2012-0099; Panel members: Richard Baker, Claude Bragard, Thierry Mead, John Jaeger, Oksa Ivlevova-Karadjova, Christine M. Tond, Rafael, Vittorio Rossi, Jan Schick, Greta Schoedel, Wopke van der Werf and Stephan Winter. Correspondence: Greta Schoedel, EFSA, Parma, Italy. Suggested citation: EFSA Panel on Plant Health (PLH) (2013) Scientific Opinion on the potential establishment of the island apple snail, *Pomacea insularum*, in the EU. *EFSA Journal* 2013;11(12):3487. doi:10.1002/efsa.2013.11.12.3487

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 **EFSA Journal** 2014;12(4):3641

SCIENTIFIC OPINION

Scientific Opinion on the environmental risk assessment of the apple snail for the EU¹

EFSA Panel on Plant Health (PLH)^{2,3}
European Food Safety Authority (EFSA), Parma, Italy

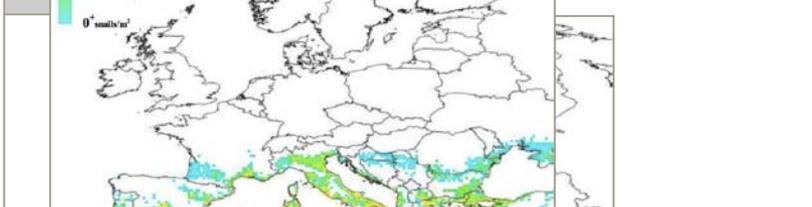
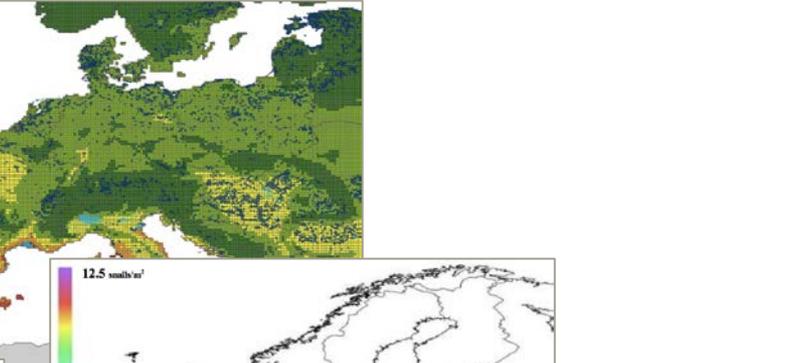
ABSTRACT

At EFSA's request, the Plant Health Panel (PLH) performed an environmental risk assessment (ERA) of the apple snail for the EU and validated the ERA approach presented in the PLH ERA guidance document. Improvements and suggestions for simplification of the ERA are provided. One service-providing unit—shallow fresh water areas—was identified for this ERA. The effects of resistance, resilience and management on snail population dynamics in the short (30 years) and the long term (50 years) were estimated. In line with the PLH ERA guidance rating system, expert judgement was used to evaluate separately the impacts on (i) ecosystem traits, (ii) ecosystem services and (iii) biodiversity components. Snail biomass values were predicted to be higher in the short term than in the long term. For ecosystem services, moderate risk was estimated for genetic resources, climate regulation, pest and disease regulation and pollination in both the short and long term; for food, risk was assessed as moderate in the short term and major in the long term; for water and erosion regulation, risk was assessed as major both in the short term and in the long term; for nutrient cycling and phytoynthesis and primary production of macrophytes, risk was assessed as massive in the short term and as major in the long term. For biodiversity components, risk for genetic diversity and native species diversity was estimated as major in both the short and long term; risk for native habitats was assessed as massive in the short term and major in the long term, and for threatened species and habitats of high conservation value, risk was determined as massive in both the short and the long term.

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KEY WORDS

apple snail, *Pomacea* spp., environmental risk assessment, scenario analysis, ecosystem traits, ecosystem services, biodiversity components



¹ On request from EFSA, Question No EFSA-Q-2013-00739, adopted on 31 March 2014.

² Panel members: Richard Baker, Claude Bragard, Thierry Candresse, Gianni Gilardi, Jean-Claude Gesteira, Inere Holt, Michael John Jaeger, Oksa Ivlevova-Karadjova, Christine Magnusson, David Makarewicz, Charles Makarewicz, Maria Novotna, Tond Rafael, Vittorio Rossi, Jan Schick, Greta Schoedel, Greta Schoedel, Wopke van der Werf and Stephan Winter. Correspondence: Greta Schoedel, EFSA, Parma, Italy.

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Suggested citation: EFSA Panel on Plant Health (PLH) (2014) Scientific Opinion on the environmental risk assessment of the apple snail for the EU. *EFSA Journal* 2014;12(4):3641. doi:10.1002/efsa.2014.12.4.3641

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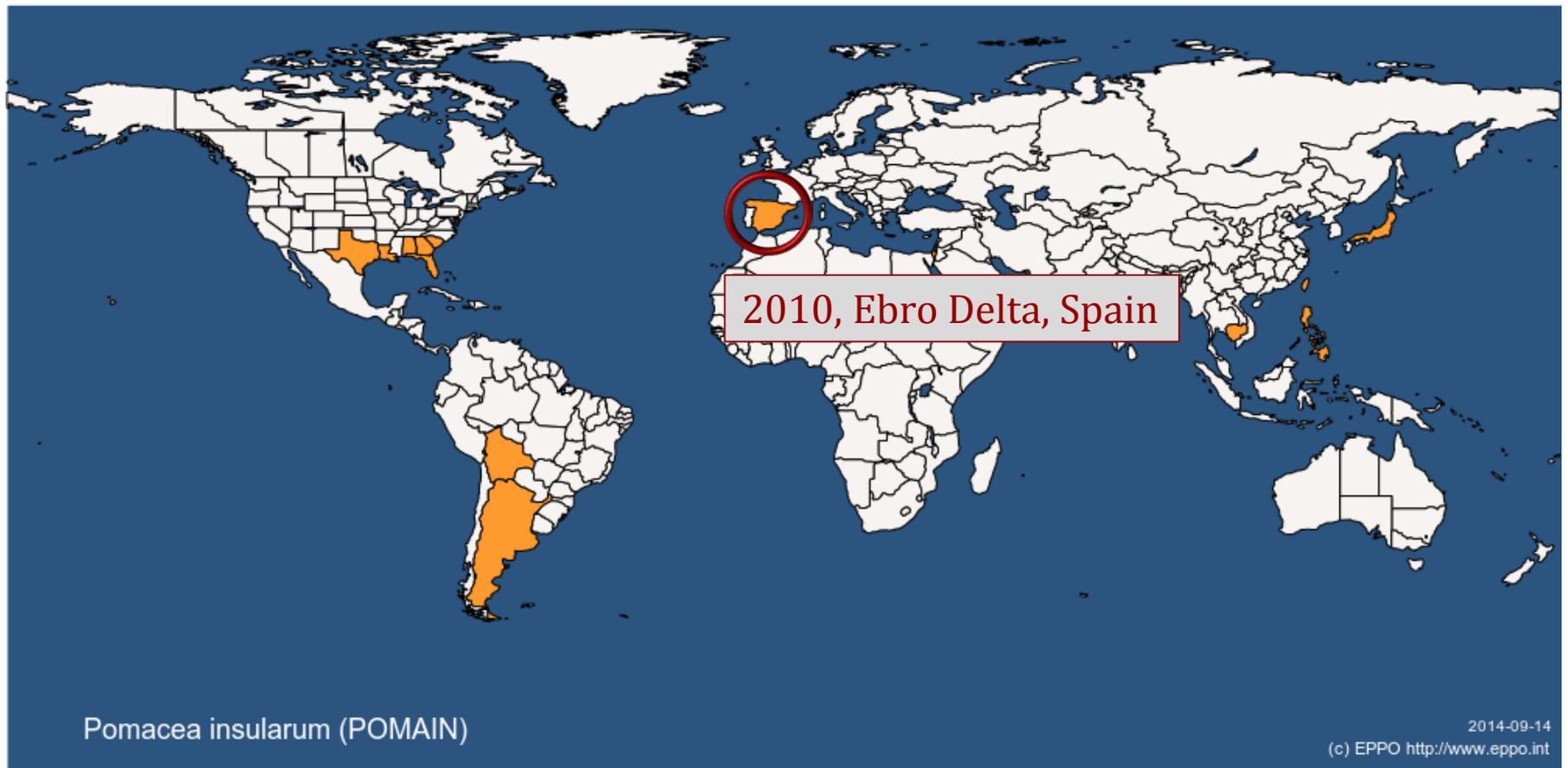
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The invasive apple snails (*Pomacea* spp.)

- Originally from South or Central America → Asia, North America, Europe
- Three developmental stages: eggs, juveniles, adults
- Extremely adaptive to environmental conditions in wetlands, freshwater ecosystems and rice paddies
- Extremely polyphagous
- Highly reproductive
- Damaging freshwater macrophytes predominant environments
- One of the 100 World's Worst Invasive Alien Species

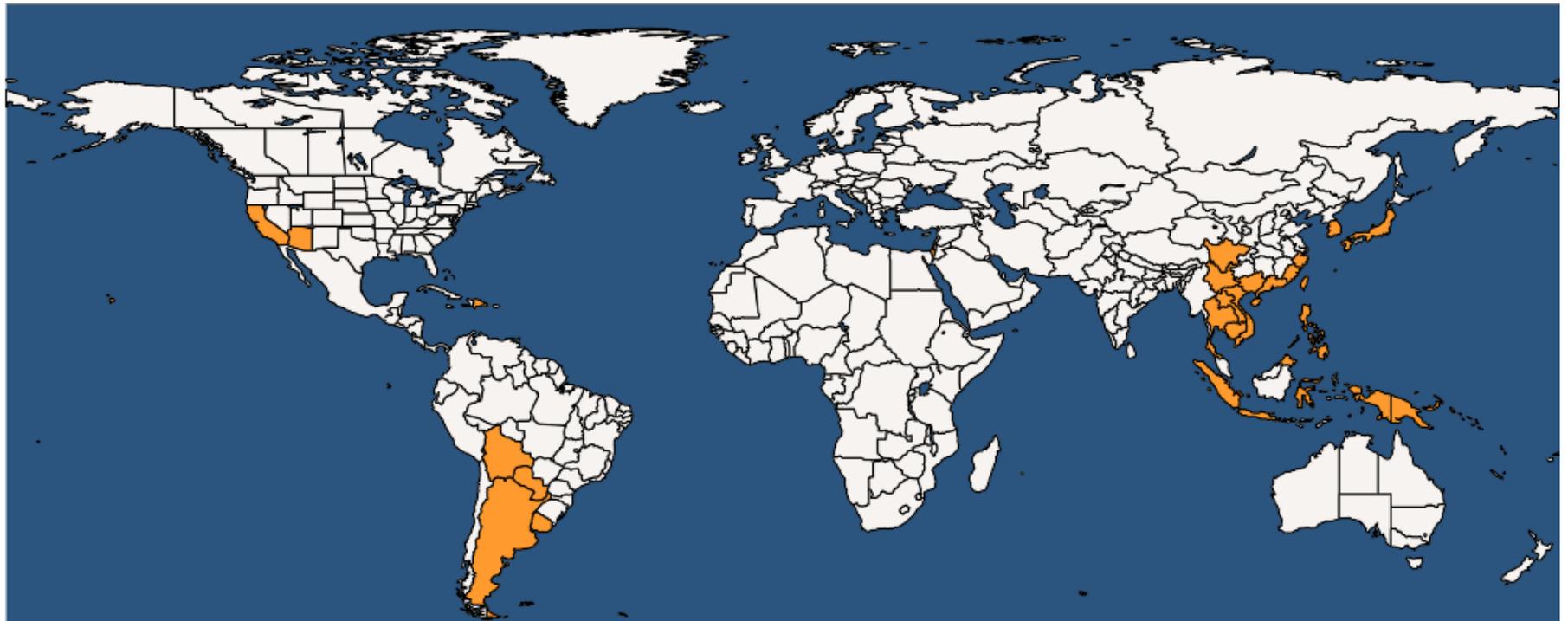
Distribution

P. maculata



Distribution

P. canaliculata



Pomacea canaliculata (POMACA)

2016-08-08
(c) EPPO <http://www.eppo.int>

From the potential distribution to the impact

- Density or biomass per unit area of an invasive species is a key predictor of the magnitude of environmental and economic impact in the invaded habitat
- The combination of climatic and habitat variables is a powerful way to model the distributions of invasive species but does not provide us with information about the variability and adaptability of life-history traits, their consequences on population dynamics, nor on how the density of the invader across different geographical scales is distributed.
- Physiologically-based modelling increases our ability to forecast the spatio-temporal pattern of population dynamics of the same invader within the potential, invadable geographical range
- Provide information about when, and where, risk reducing options and control measures would be most effective considering how they can modify population abundance

An effective approach

- ◆ In this study, we use the highly invasive snail *P. canaliculata* as a case study illustrating the potentiality of the physiologically-based demographic modelling approach to describe and forecast population dynamics of an invasive species at different locations.
- The approach followed in this work allows to roughly translate the potential densities into an estimated impact on biodiversity, ecosystem services and local economies (for example agriculture, forestry or fishery) in different areas
- The availability of information on the driver of the environmental impact can support risk management measures, for instance management efforts can be concentrated to “hot spots” (i.e. high density areas) where the negative effects of an invader are likely to be high

Data collections and methods

✧ *The information layer related to the wetlands and other suitable habitats of apple snails should be added to the maps of potential distribution, in order to properly define the area at risk of establishment*

1. *P. canaliculata* biomass data points obtained from the model [juveniles + adults]
 2. Data on wetlands and freshwater ecosystems [GIEMS - D15]
 3. Data on European protected areas [Natura 2000]
- Interpolation and overlay (QGIS and GRASS)
 - Statistics based on biomass ranges of *P. canaliculata* in Europe

1) Model development and biomass data points

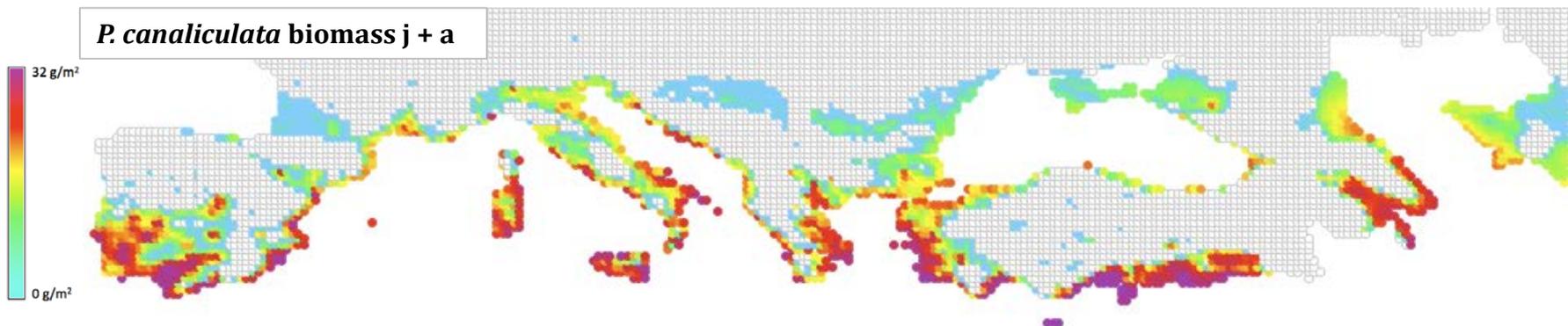
- **Temperature-dependent physiologically-based demographic model**
 - Water/air temperature dependent development, fecundity and mortality rate functions
 - Hourly values of water and air temperature have been simulated for each point of a 0.25 X 0.25 degrees grid based on the daily maximum and minimum air temperature of the 10 closest weather stations of NOAA-GSOD dataset
 - The potential snail biomass, defined as the biomass in a given point of the considered grid where a suitable habitat is present at a time t , has been obtained and expressed in g/m^2
 - The stochastic model accounts for biological variability and uncertainty

P. canaliculata biomass data points



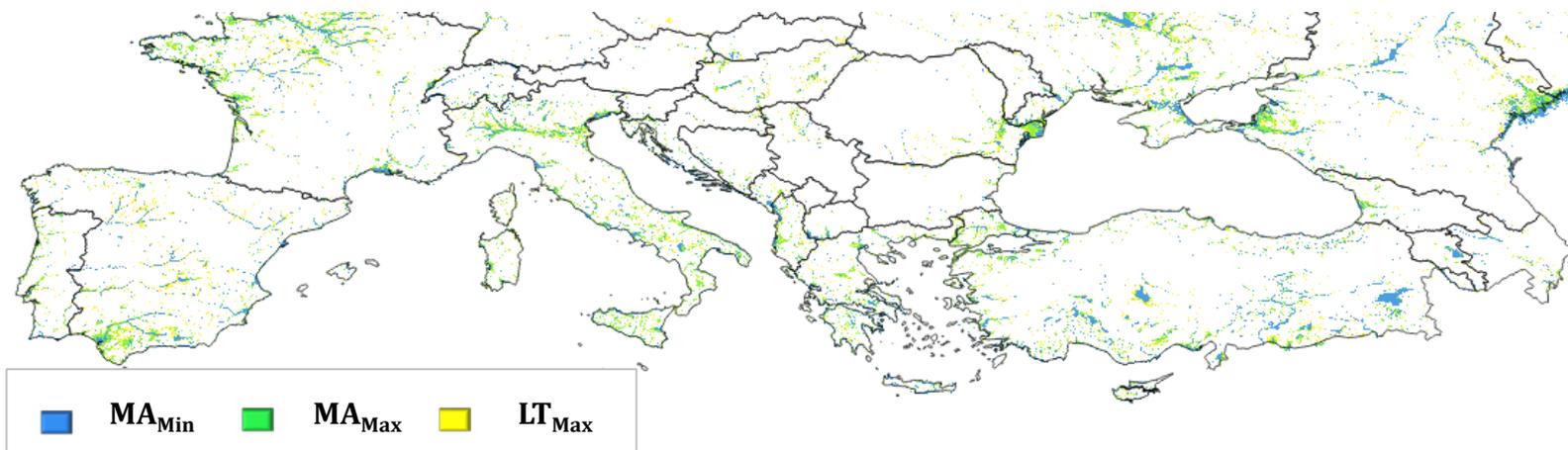
1) Model development and biomass data points

- **Temperature-dependent physiologically-based demographic model**
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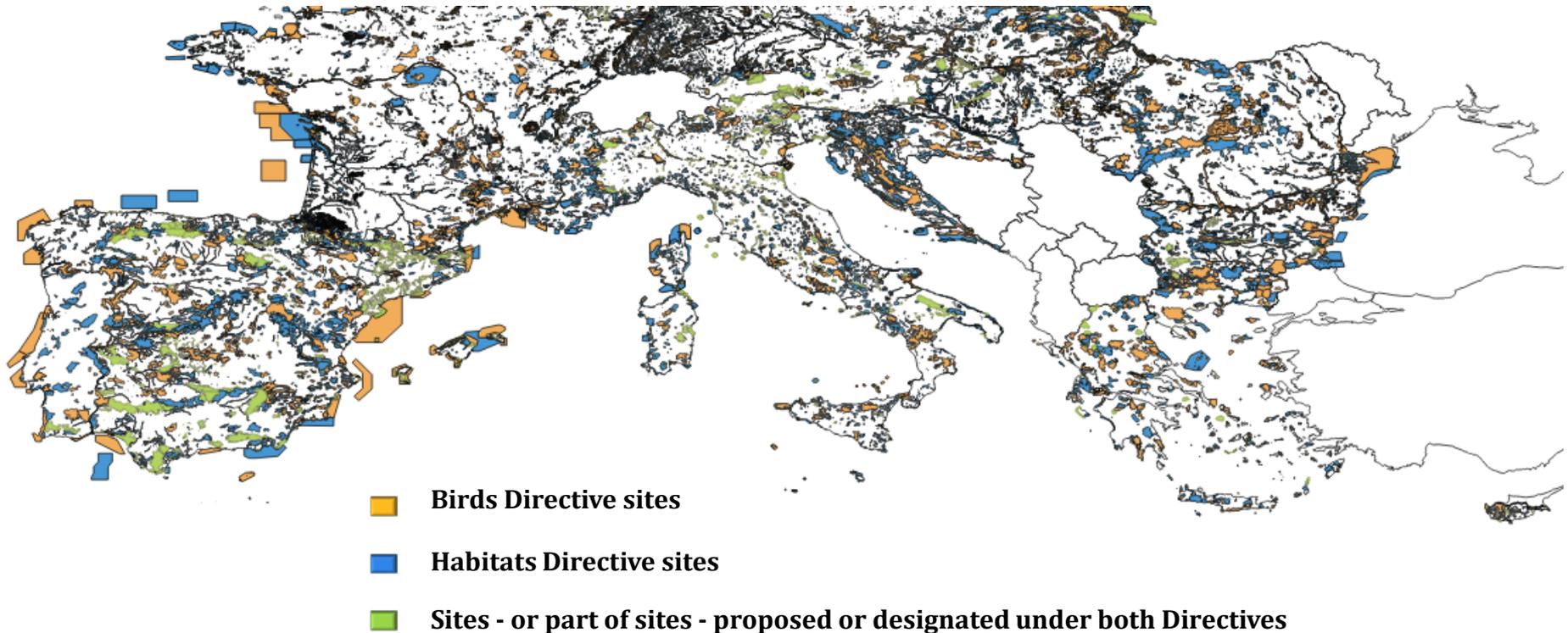
2) Data on wetlands and freshwater ecosystems

- The Global Inundation Extent from Multi-Satellite dataset downscaled to 15 arc-seconds (~ 500 meters at the equator)
 - Monthly data on surface water extent over a 12-year time period of observations together with data on wetlands extent from the Global Lakes and Wetlands Database (GLWD)
 - Three states of global inundation extents: the mean annual minimum (MA_{Min}), the mean annual maximum (MA_{Max}) and the long-term maximum (LT_{Max})



3) Data on European protected areas

- The Natura 2000 database
 - Birds Directive and Habitats Directive



Methods for...

- **Interpolation and overlay**

- Regularized Spline with Tension (RST)
- GIEMS mask overlay
- Natura 2000 overlay

v.surf.rst
(GRASS)

tension 100

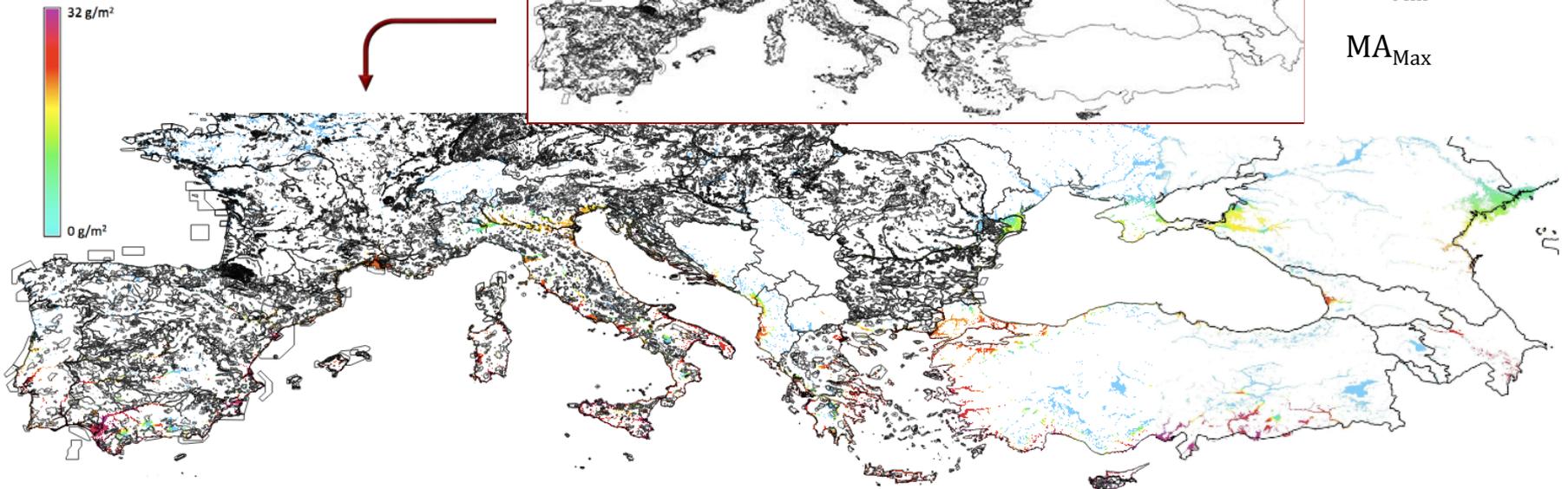
smoothing 0.01

+



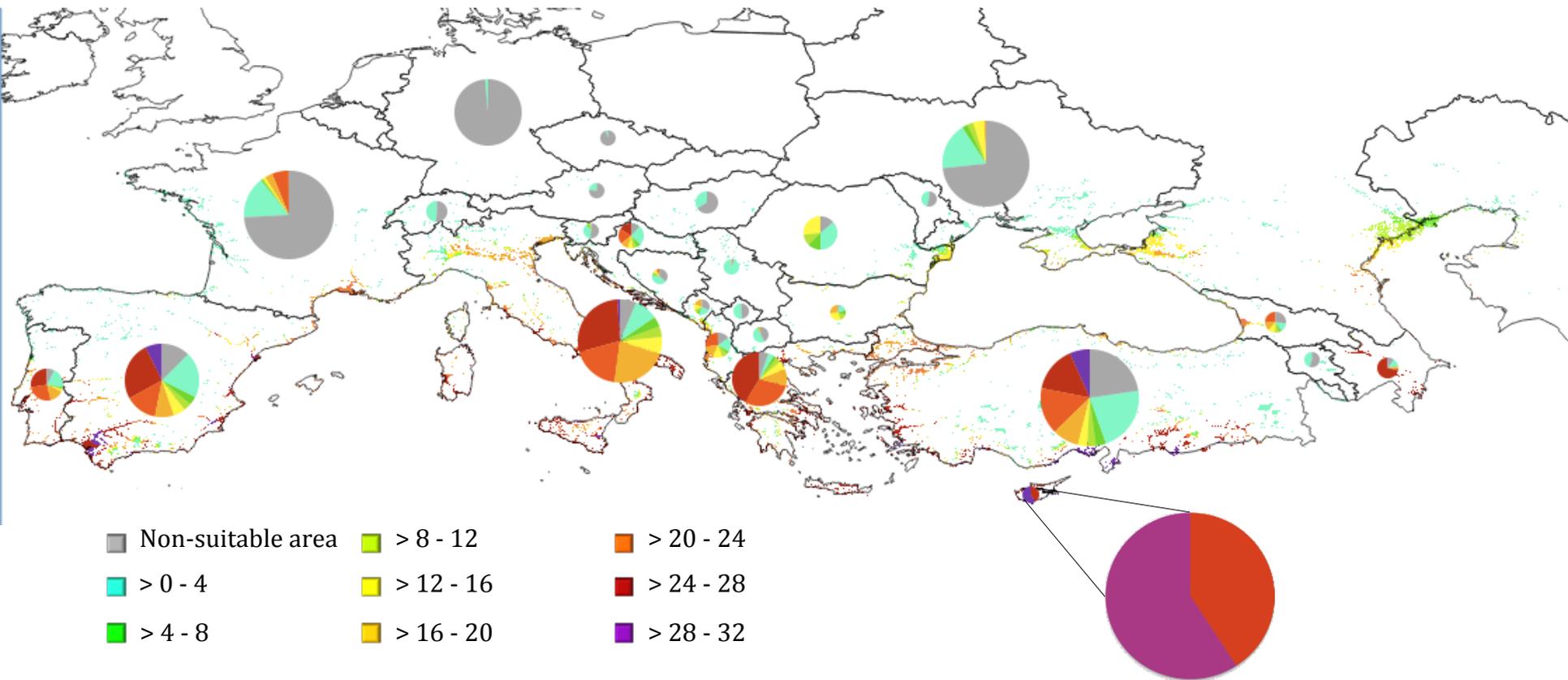
MA_{Min}

MA_{Max}



Results - part 1

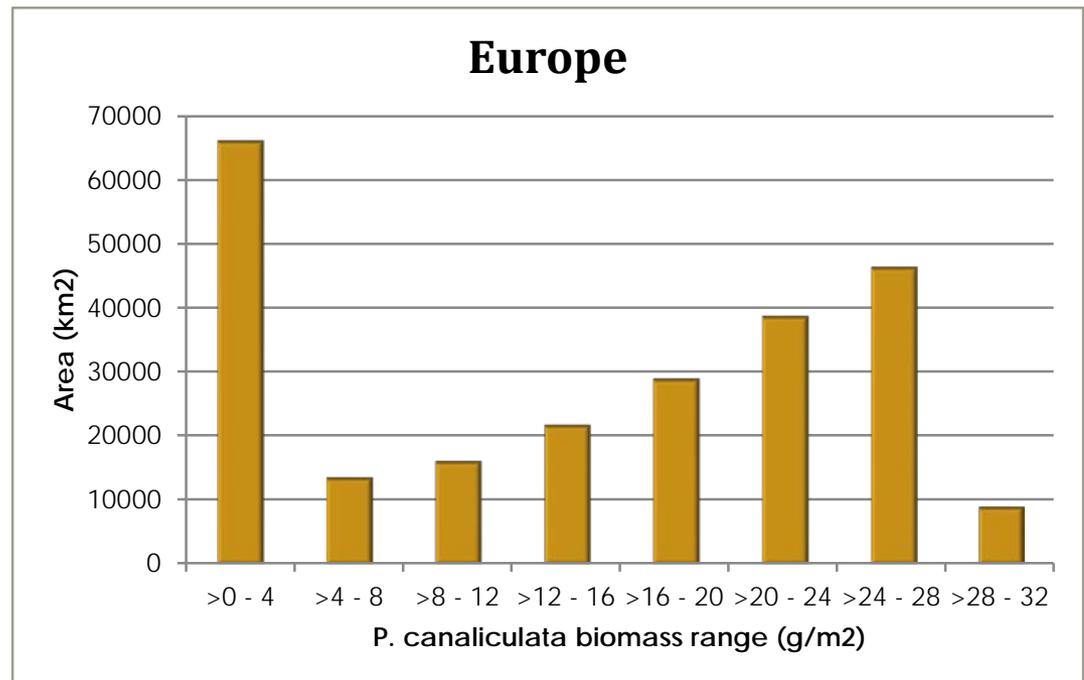
P. canaliculata biomass (g/m^2) > 0



Results - part 1

European total surface (Km²) potentially affected by *P. canaliculata* per biomass sub-range (g/m²)

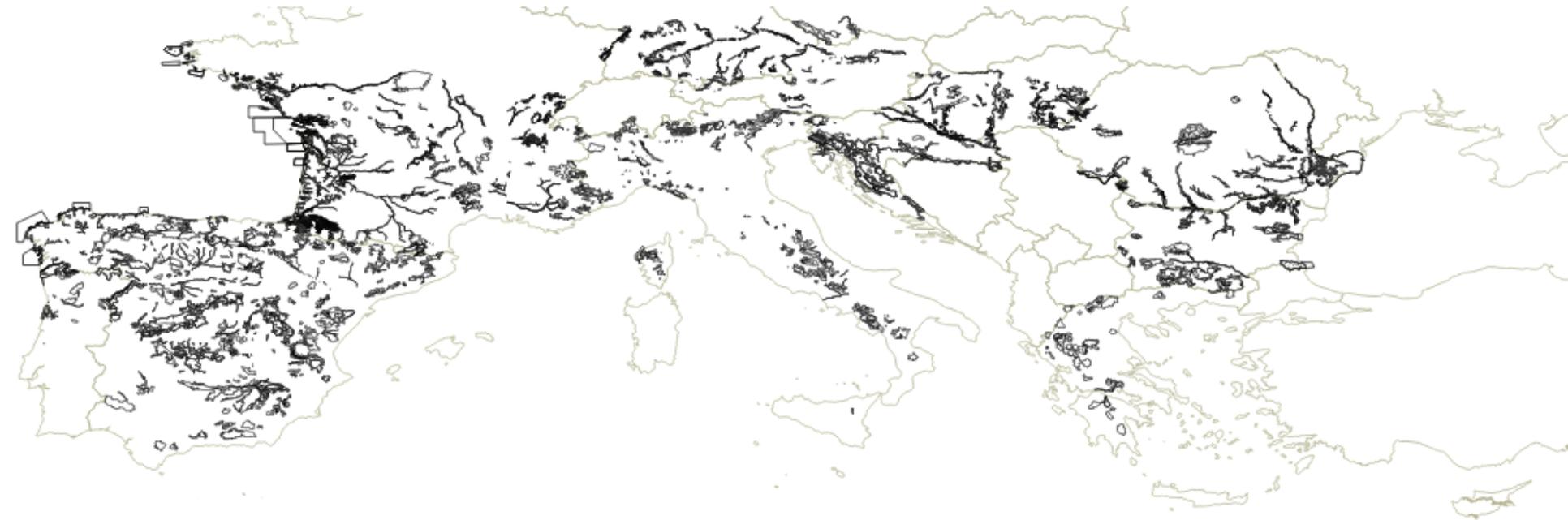
Europe	
<i>P. canaliculata</i> biomass range (g/m ²)	Area (Km ²)
>0 - 4	65801
>4 - 8	13203
>8 - 12	15808
>12 - 16	21480
>16 - 20	28668
>20 - 24	38356
>24 - 28	46044
>28 - 32	8578
TOT.	237938



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

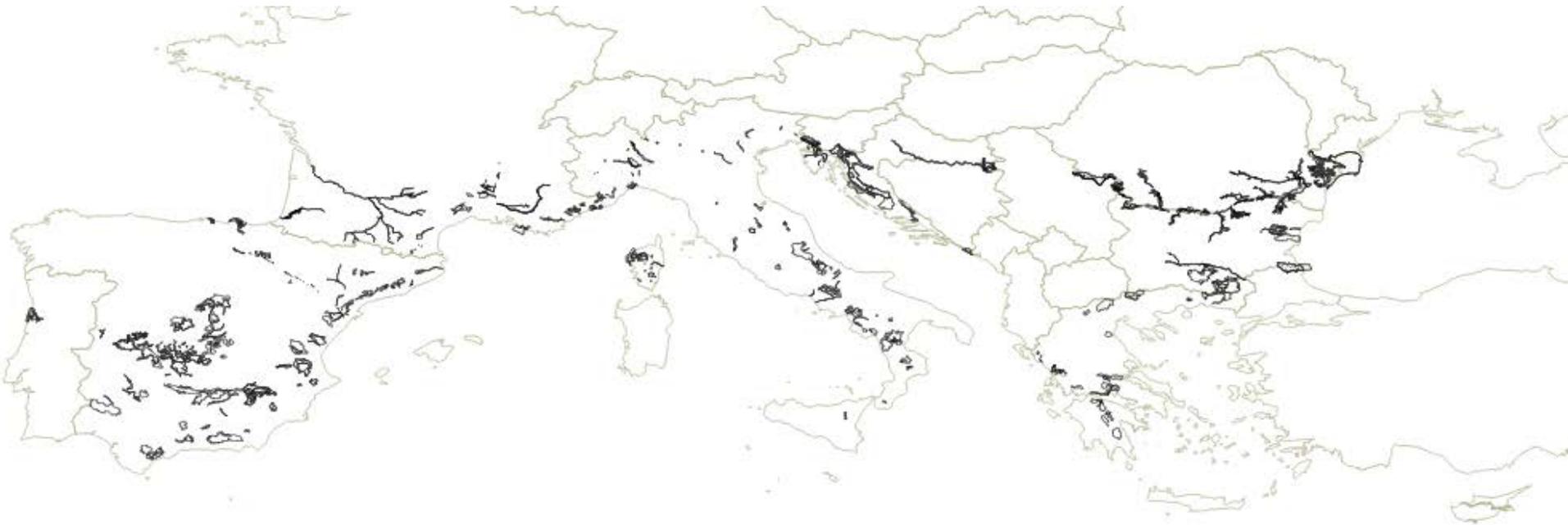
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Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

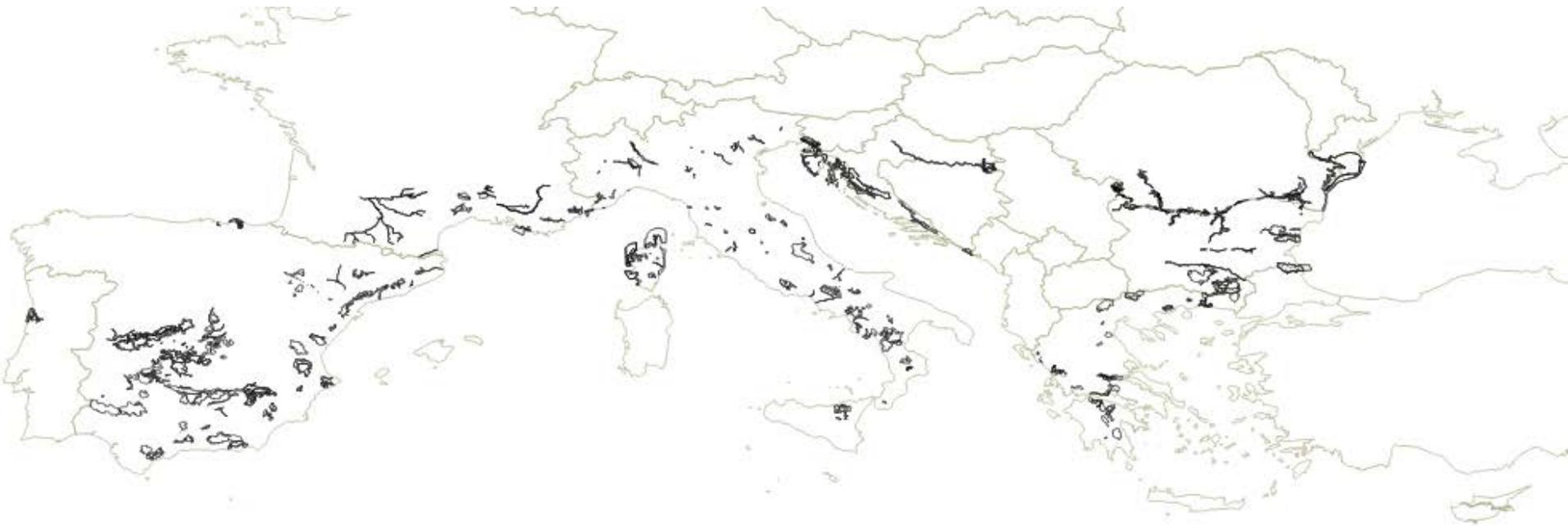
> 4 - 8



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

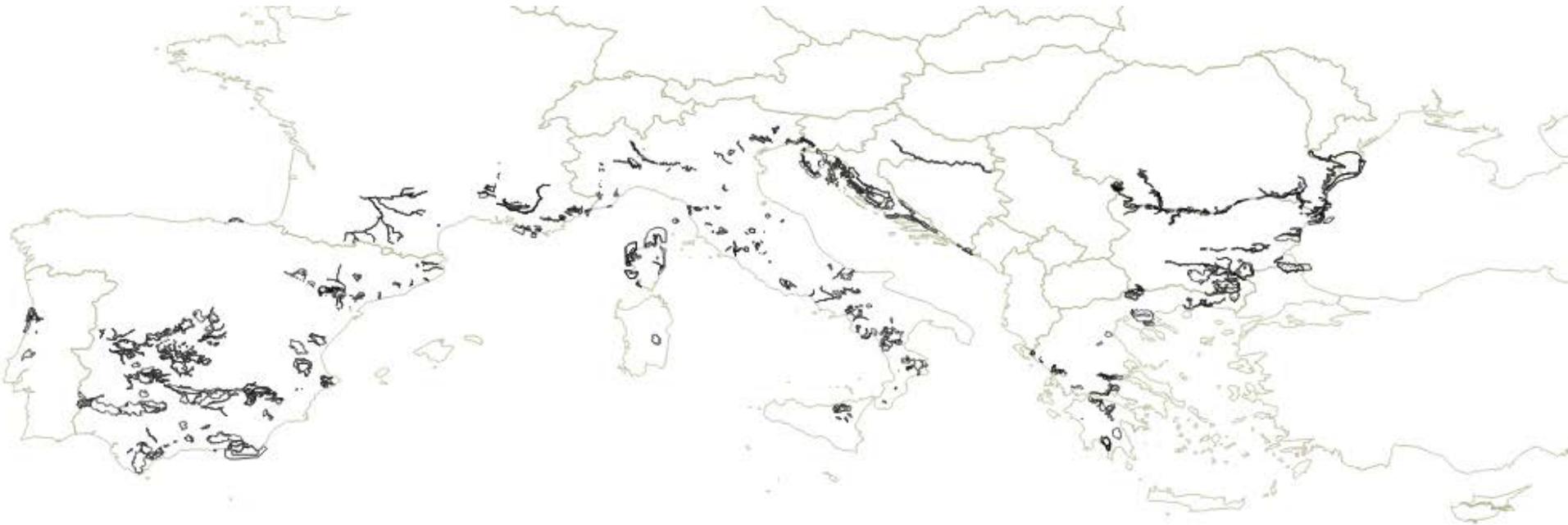
> 8 - 12



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

> 12 - 16



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

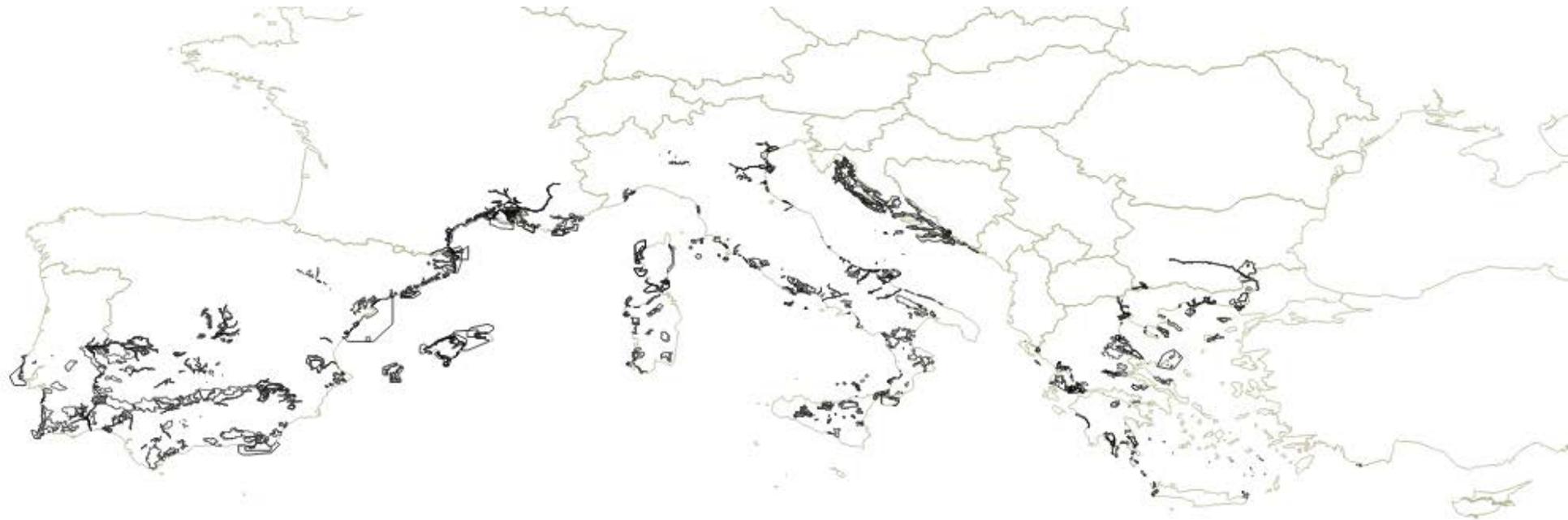
> 16 - 20



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

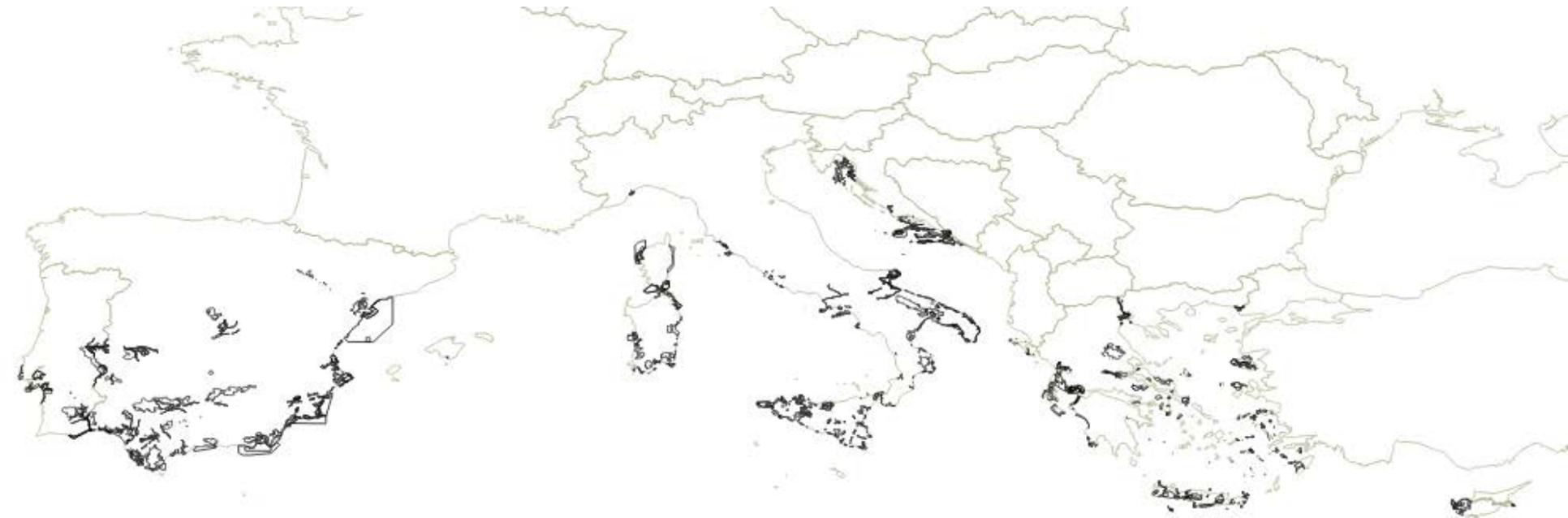
> 20 - 24



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

> 24 - 28



Results - part 2

Natura 2000 areas with *P. canaliculata* biomass (g/m²) > 0

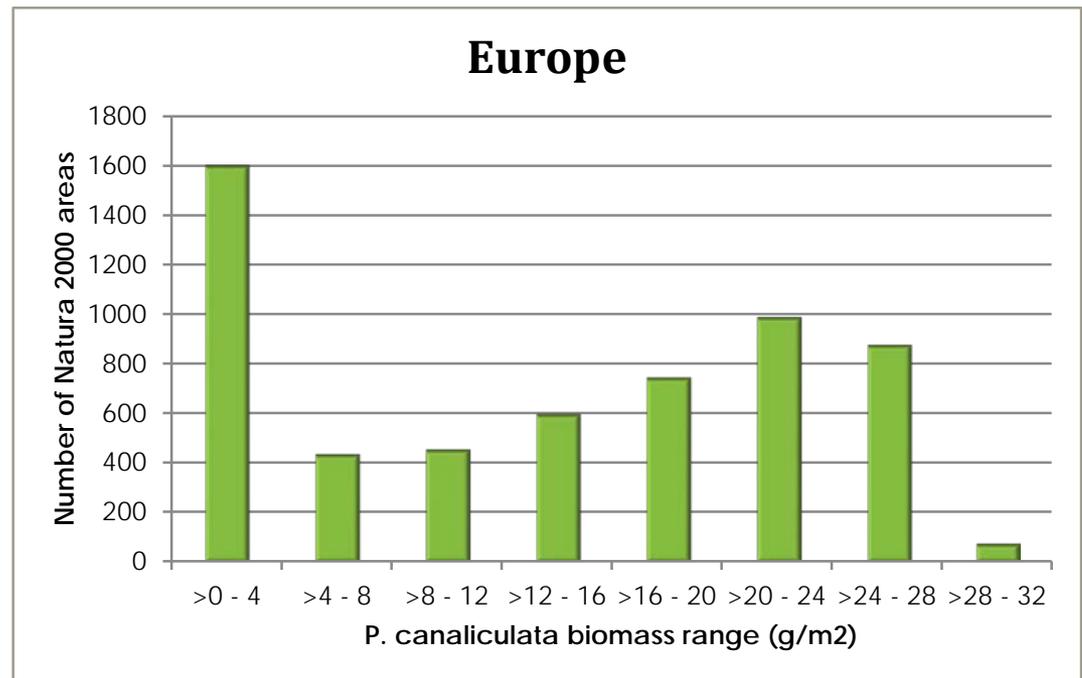
> 28 - 32



Results - part 2

Number of European Natura 2000 areas potentially affected by *P. canaliculata* per biomass sub-range (g/m²)

Europe	
<i>P. canaliculata</i> biomass range (g/m ²)	Number of Natura 2000 areas
>0 - 4	1596
>4 - 8	435
>8 - 12	455
>12 - 16	597
>16 - 20	743
>20 - 24	986
>24 - 28	874
>28 - 32	72
TOT.	5758



Conclusions and final remarks

- Wetlands and freshwater ecosystems have been included and the area (Km²) potentially affected by *Pomacea* spp. has been extrapolated per country and sub-range
- The number of protected areas under Natura 2000 that could be potentially affected by *Pomacea* spp. have been identified per country and sub-range



Support to risk managers

- WHAT'S NEXT?

Further mapping based on the impacts on ecosystems traits, ecosystems services and biodiversity components, taking into account different scenarios resulting from the influence and variability of resistance, resilience and management

Acknowledgments

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- Fluet-Chouinard, E., Lehner, B., Rebelo, L.-M., Papa, F., & Hamilton, S. K. (2015). Development of a global inundation map at high spatial resolution from topographic downscaling of coarse-scale remote sensing data. *Remote Sensing of Environment*, 158, 348–361.
- Prigent, C., Papa, F., Aires, F., Rossow, W. B. & Matthews, E. (2007). Global inundation dynamics inferred from multiple satellite observations, 1993-2000. *Journal of Geophysical Research*, 112(D12107): 1-1.



THANK YOU!