

Physiologically based model to assess the probability of establishment of plant pests including a case study on *Pomacea* spp.

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**University of Brescia
EFSA PLH Panel**

JOINT EFSA-EPPO WORKSHOP

Modelling in Plant Health: How can models support risk assessment of plant pests and decision making?

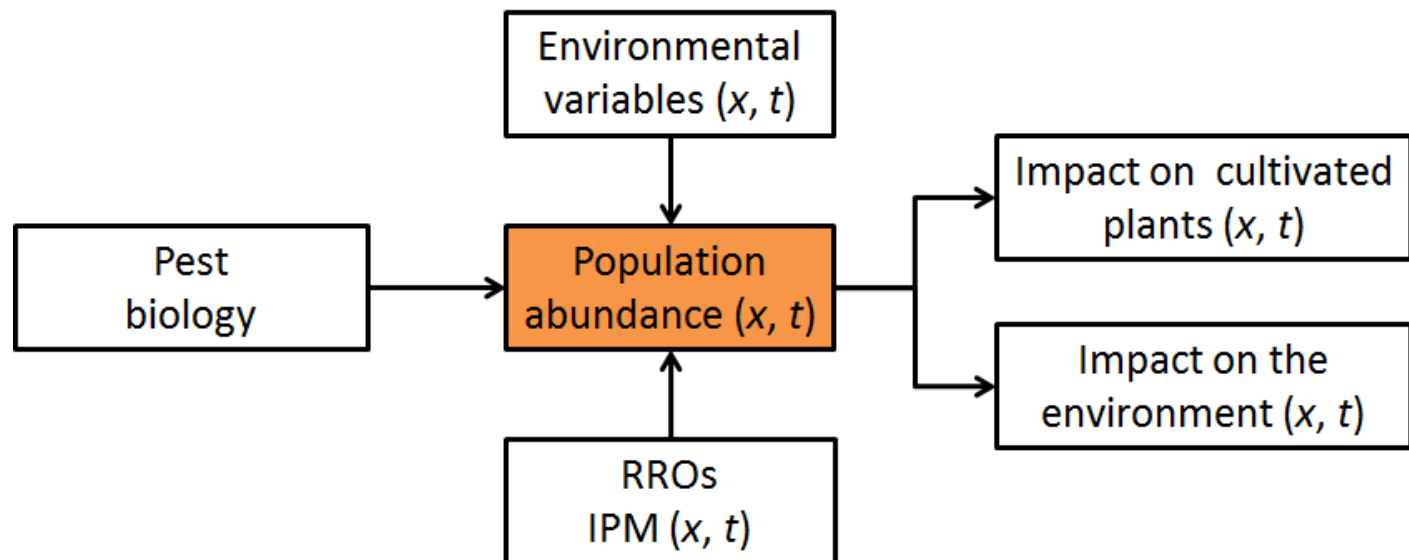
Parma, 12-14 December, 2016

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PEST POPULATION ABUNDANCE

- Pest risk analysis requires the identification of areas for potential establishment of a pest to assess the risk posed to agriculture and the environment
- Pest abundance is considered as a predictor of the magnitude of impacts in the invaded habitat in the area for potential establishment



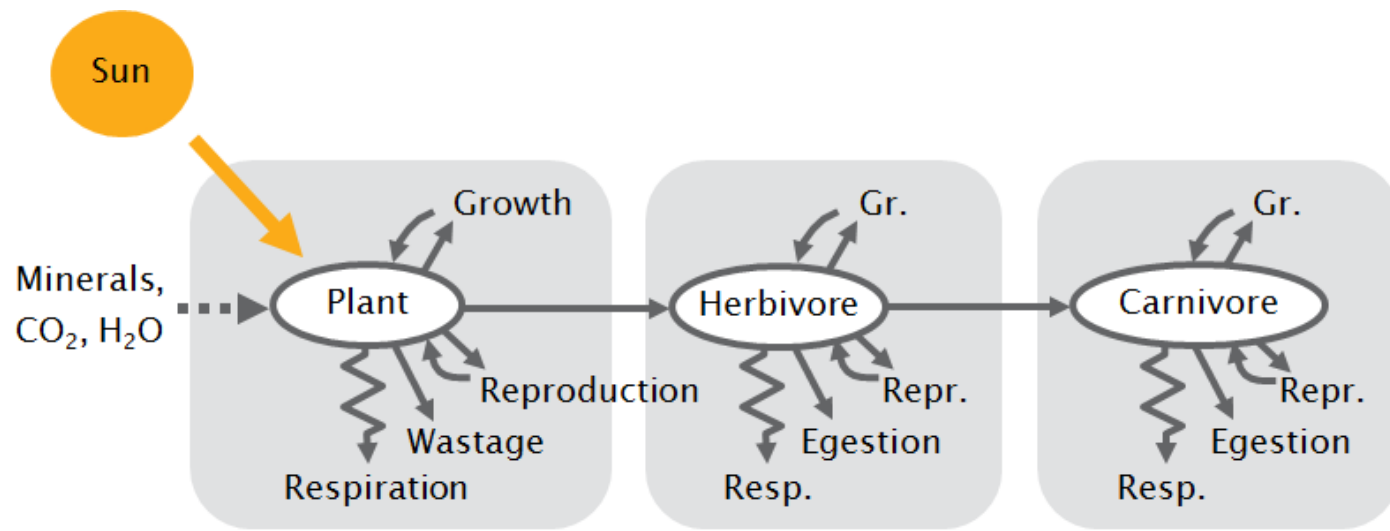


THE PBDM METHODOLOGICAL FRAMEWORK

- Physiologically-Based Demographic Models (PBDM) methodological framework
 - (i) provides an appropriate level of mechanistic synthesis for predicting pest population phenology, age structure and abundance dynamics as a function of the spatial and temporal variability of environmental forcing variables
 - (ii) able to define the area of potential establishment on the basis of the physiologically-based approach to population dynamics modelling
 - (iii) uses the population abundance (whatever defined) as the driver that can better explain the impact on cultivated plant and environment
 - (iv) scenario-based analysis supporting risk managers in their decision making process

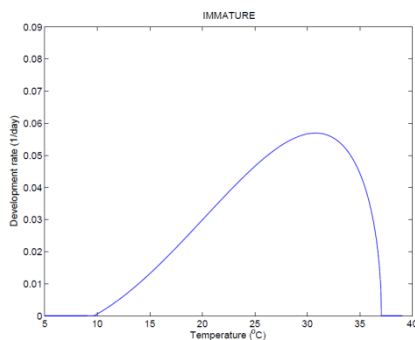
THE PBDM APPROACH: THE PROCESSES

- Pest is a player in a trophic network → each level supplies resource to the next
- The dynamics of system abundance can be described using the same model in all trophic levels
- The processes
 - Have similar shapes described by the same functions
 - Are based on the supply/demand ratio for resources

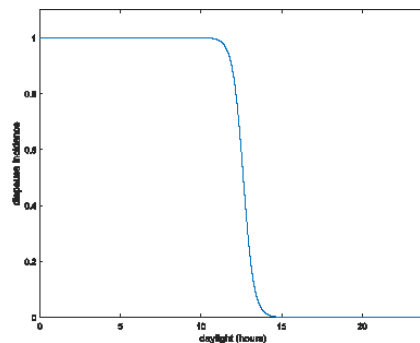


THE PBDM APPROACH: THE PROCESSES

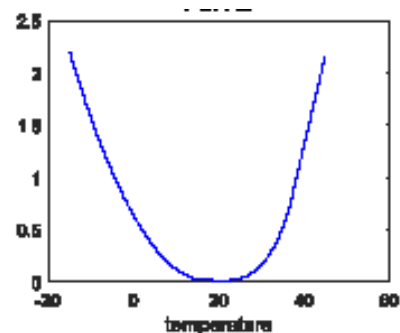
■ Functions describing biological/ecological traits



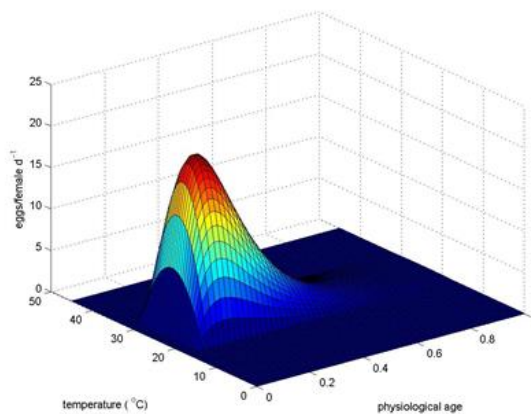
Development rate



Induction of diapause



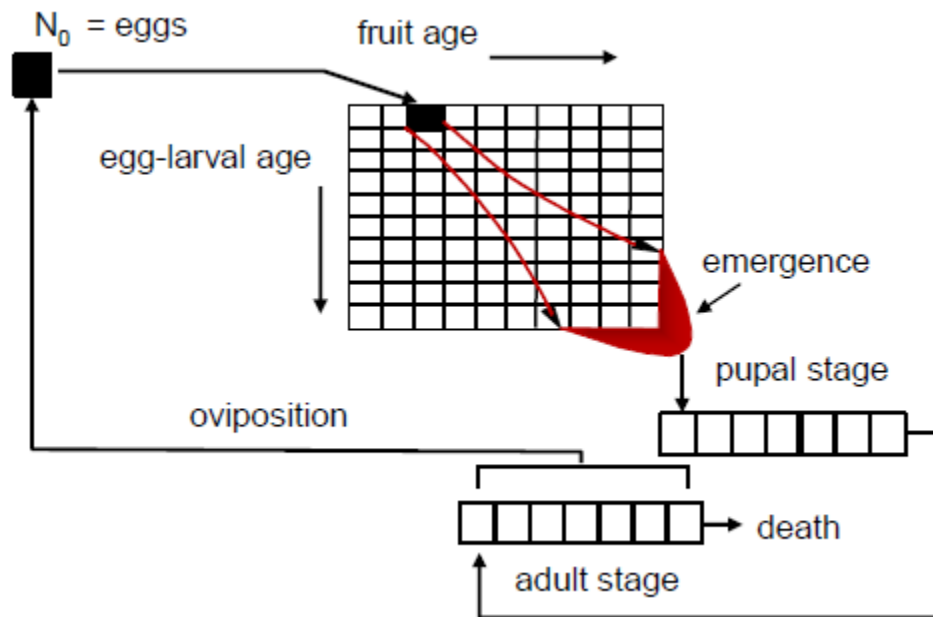
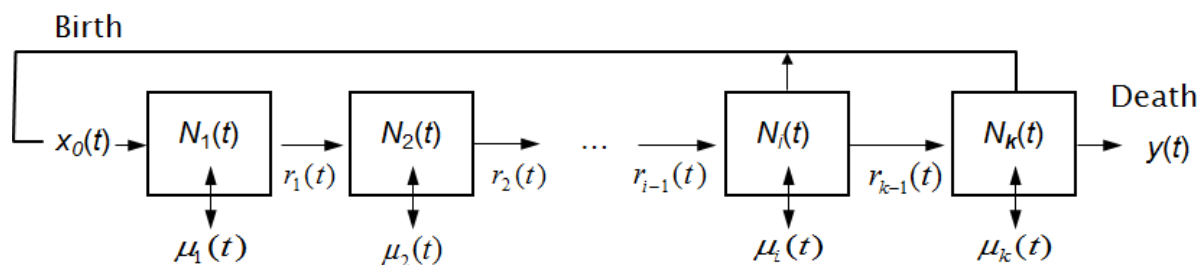
Mortality rate



Fecundity rate

THE PBDM APPROACH: THE TEMPORAL DYNAMICS

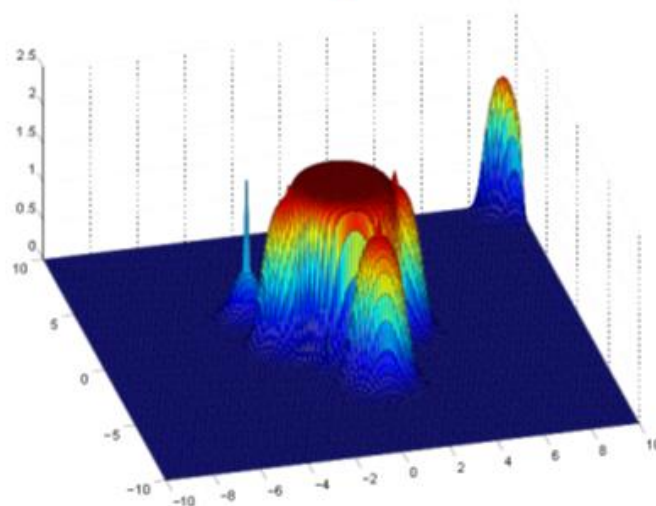
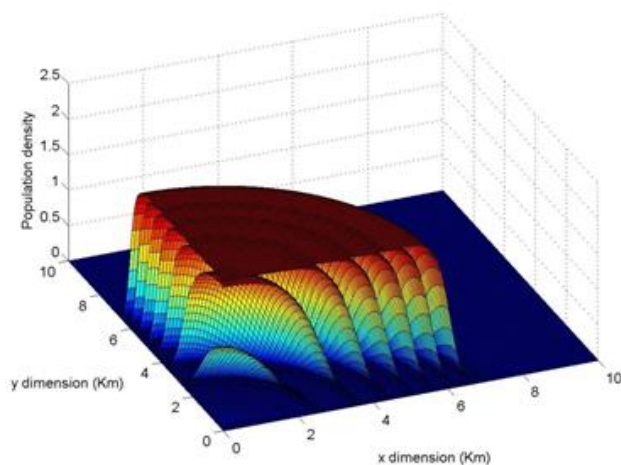
- Temporal population dynamics is described by PBDM



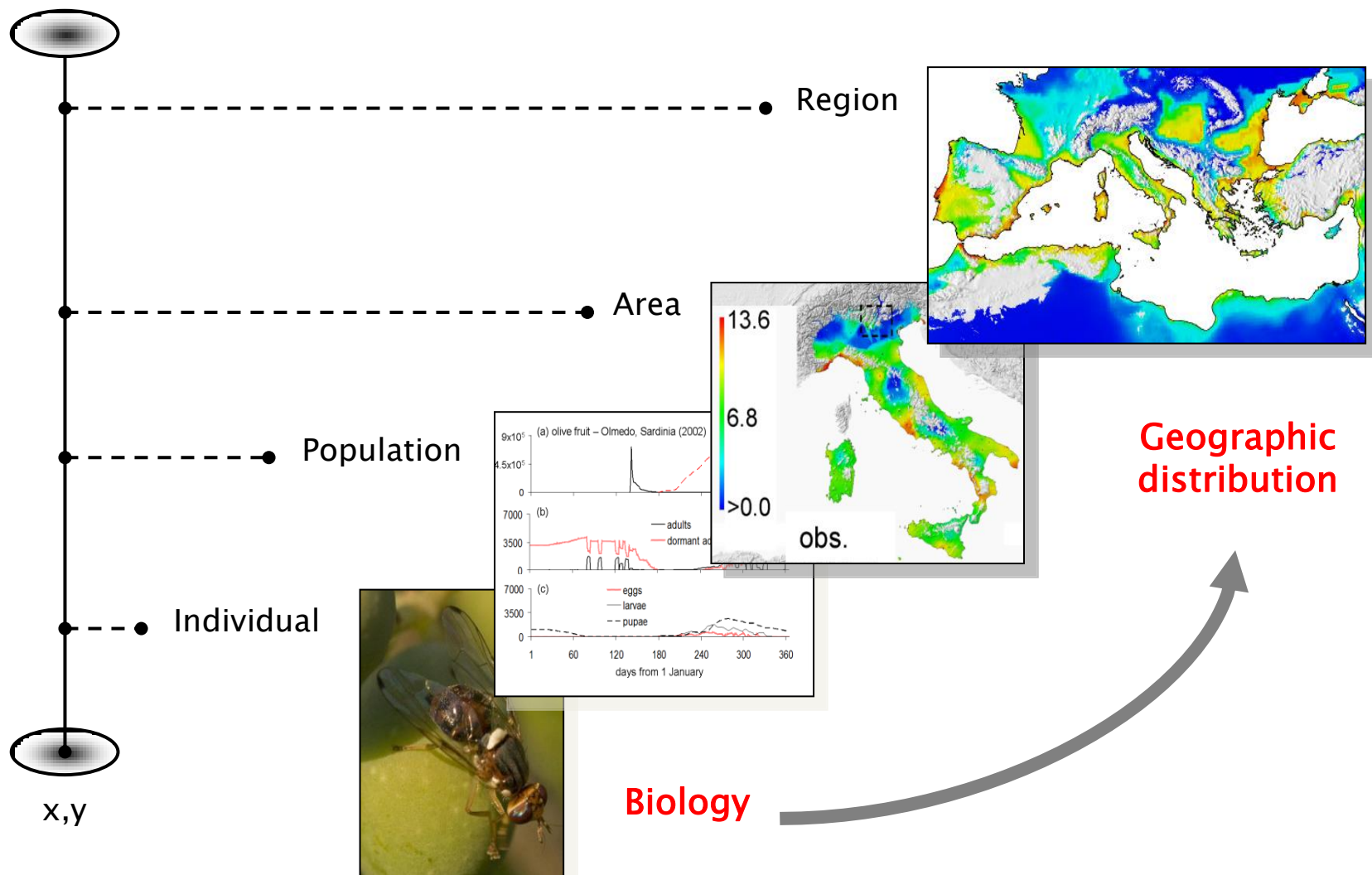
THE PBDM APPROACH: THE SPATIAL DYNAMICS

$$N_{t+1}(\mathbf{x}) = \int_{\mathbb{R}^2} \frac{1}{2\pi\sigma^2} \exp\left(-\frac{|\mathbf{x}-\mathbf{y}|^2}{2\sigma^2}\right) \exp\left(r_0\left(1-\frac{1}{K}N_t(\mathbf{y})\right)\right) \frac{N_t^2(\mathbf{y})}{N_t(\mathbf{y})+A} d\mathbf{y}$$

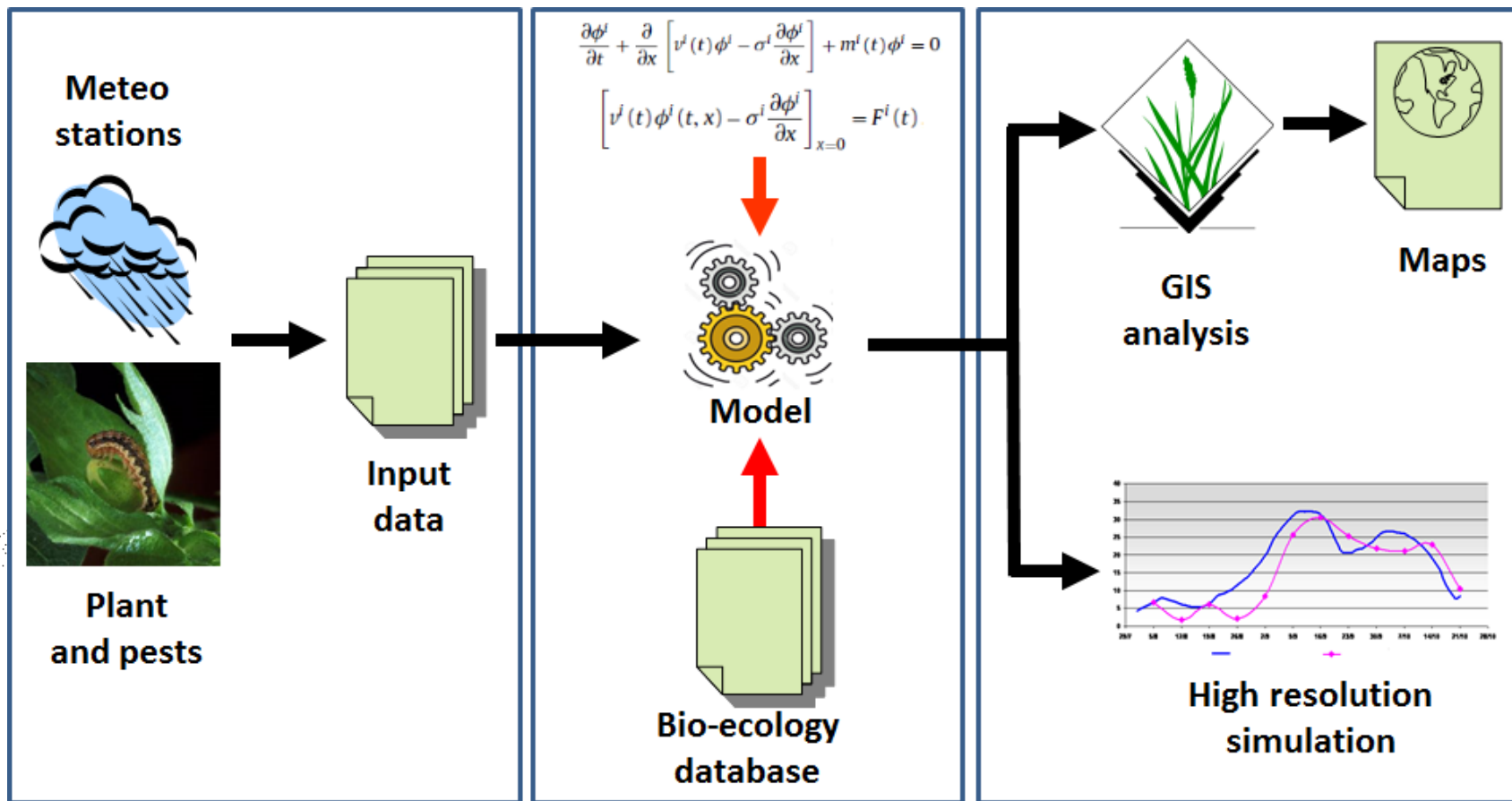
$$f(d) = \frac{1}{\beta^\alpha \Gamma(\alpha)} d^{\alpha-1} e^{-\frac{d}{\beta}} + P(M=m) = e^{-\lambda} \left(\frac{\lambda^m}{m!}\right)$$



THE PBDM APPROACH: THE SPATIAL SCALE

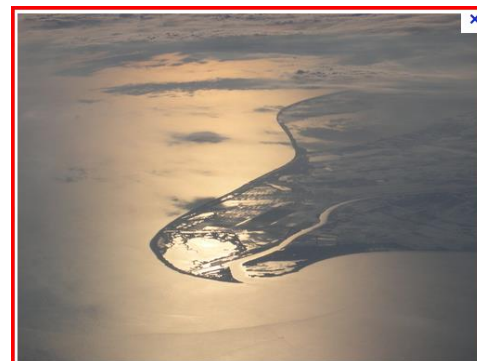
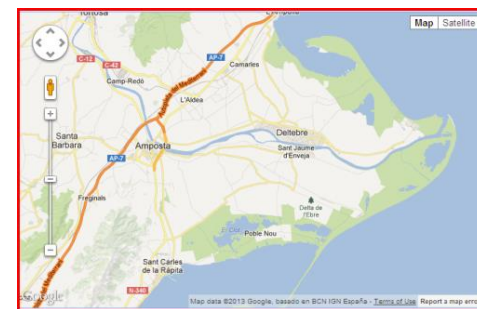


THE PBDM APPROACH: A TECHNOLOGICAL PLATFORM



THE *Pomacea* spp. CASE STUDY

- Originally from South or Central America
 → Asia, North America, Europe
 - 2009 apple snail invasion in the Ebro Delta in Spain
- Use of the highly invasive snail *Pomacea* as a case study illustrating the potentiality of the PBDM approach to describe and forecast population dynamics of an invasive species at different locations



THE *Pomacea* spp. CASE STUDY



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 Affairs¹

EFSA Panel on
European Food

ABSTRACT

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

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KEY WORDS

apple snail, pest risk analysis, *Pomacea*



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
European Food Safety

This Scientific Opinion, published on 12 March 2014, 2013.*

ABSTRACT

EFSA requested the PLH Panel to review the current evidence in this opinion, and to perform an environmental risk assessment, which will provide the current state of the art of the biology of apple snail assess the potential establishment of apple snails in the *Pomacea* complex and *P. maculata* was perfect characteristics related to temperature, which was used in the systematics and taxonomy of the genus *Pomacea* is a synonym of *P. maculata* and can be agreed occurs via rivers and canals, in which the snail, addition, attachment to animals (e.g. birds, cattle, human assistance results in spread through cultivation and agricultural field machinery. The potential distribution with the population dynamics model, the 0.25° x 0.25° degrees covering Europe, which resulted, establishment comprises wetlands of southern Europe (the Balkans up to the latitude of the Danube river, production areas in Europe).

© European Food Safety Authority, 2013

KEY WORDS

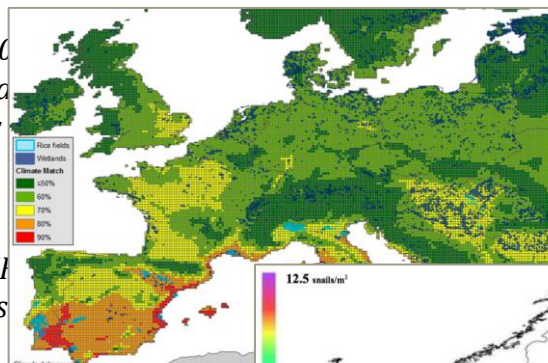
apple snail, *Pomacea insularum*, *Pomacea canaliculata*

¹ On request from EFSA, Question No EFSA-Q-2012-0091.
² Panel members: Richard Baker, Claude Bragard, Thierry Michel, John Inger, Oia Iotova-Karadjova, Christa M. Trond Røed, Vittorio Rossi, Jan Scholten, Gitta Schneider, Wopke van der Werf and Stephan Winter. Correspondence: Gitta Schneider, EFSA, Parma, Italy. E-mail: gitta.schneider@efsa.europa.eu.
³ Acknowledgement: The Panel wishes to thank the recent EFSA staff: Maria Iannone and Sylvain Vio for the preparatory work on this scientific opinion, and the hearing and EFSA staff: Maria Iannone and Sylvain Vio for the support. Corrections of an editorial nature were made to the first opinion. To avoid confusion, the original version of the request, as is a version showing all the changes made.

Suggested citation: EFSA PLH Panel (EFSA Panel on the potential establishment of the apple snail in the EU). EFSA Journal 2013;11(12):3487. Available online: www.efsa.europa.eu/efsajournal

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EFSA (2013) Scientific Opinion on the assessment of the potential establishment of the apple snail in the EU¹



Environmental risk assessment



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 (5 years) and the long term (20 years) were estimated. In line with the PLH ERA guidance 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 fresh water, risk was assessed as massive both in the short term and in the long term; and for nutrient cycling and photosynthesis 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 the 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-2013-00719, adopted on 31 March 2014.

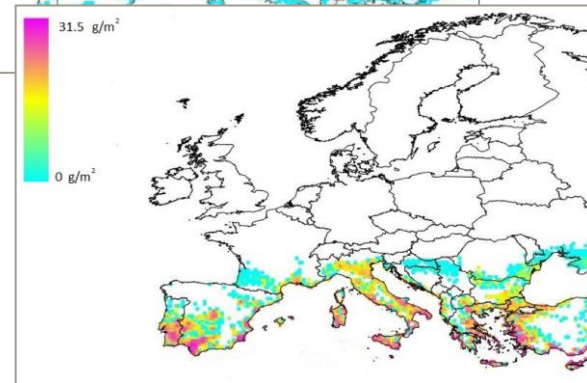
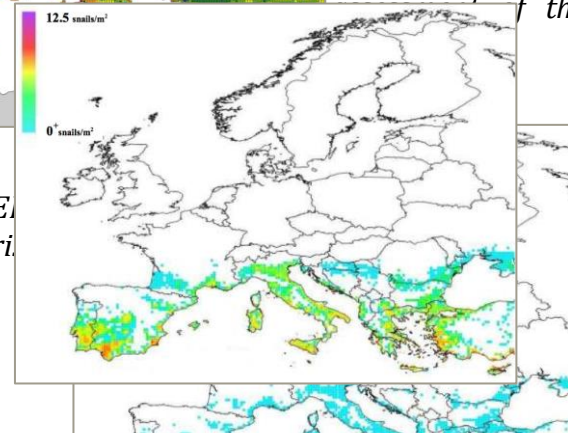
² Panel members: Richard Baker, Claude Bragard, Thierry Michel, John Inger, Oia Iotova-Karadjova, Christa M. Trond Røed, Vittorio Rossi, Jan Scholten, Gitta Schneider, Wopke van der Werf and Stephan Winter. Correspondence: Gitta Schneider, EFSA, Parma, Italy. E-mail: gitta.schneider@efsa.europa.eu.

³ Acknowledgement: The Panel wishes to thank the members of the Working Group on ERA *Pomacea*: Niki Carlsson, Gianni Gilardi, John Inger, Sylvain Vio, Pablo Rafael Martín, Sara Pasquali, and Gitta Schneider for the preparatory work on this scientific opinion, and the hearing experts: Ellen van Dorst, Casper van Leeuwen and Montserrat Vila and EFSA staff: Sylvain Vio for the support provided to this scientific opinion.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), 2014. Scientific Opinion on the environmental risk assessment of the apple snail for the EU. EFSA Journal 2014;12(4):3641. 97 pp. doi:10.2903/efsa.2014.3641. Available online: www.efsa.europa.eu/efsajournal

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Environmental risk assessment



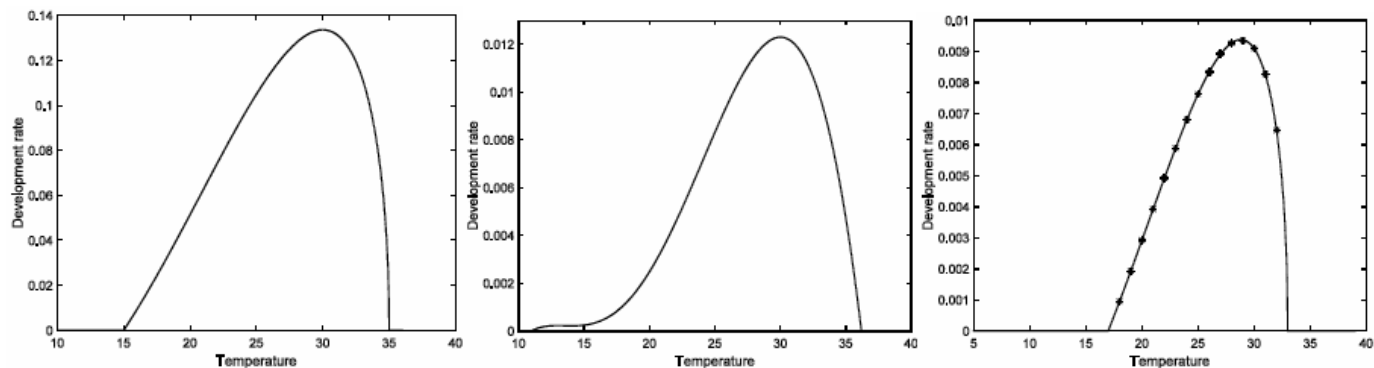
EFSA (2013) Scientific Opinion on the assessment of the potential establishment of the apple snail in the EU¹

Environmental risk assessment

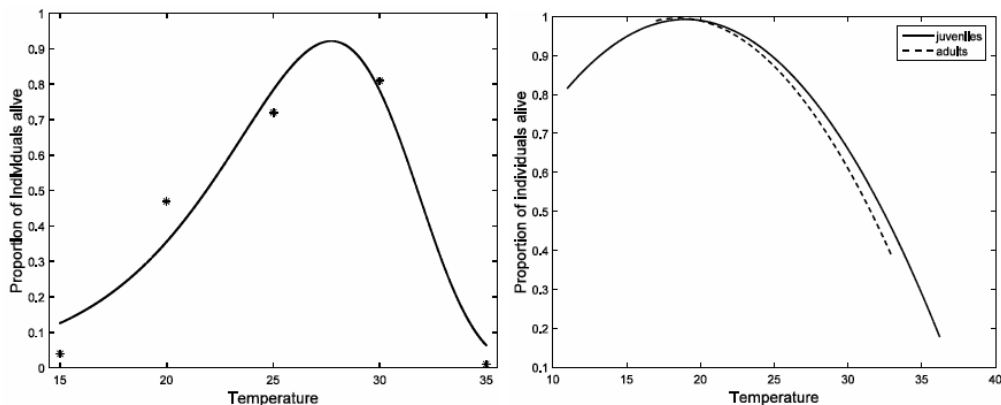
Environmental risk assessment

THE *Pomacea* spp. CASE STUDY

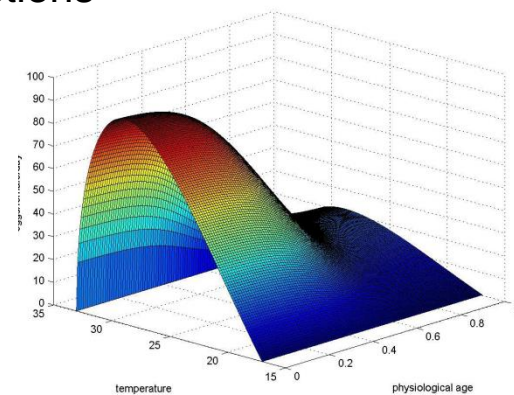
■ Model parameterization



Temperature-dependent development functions



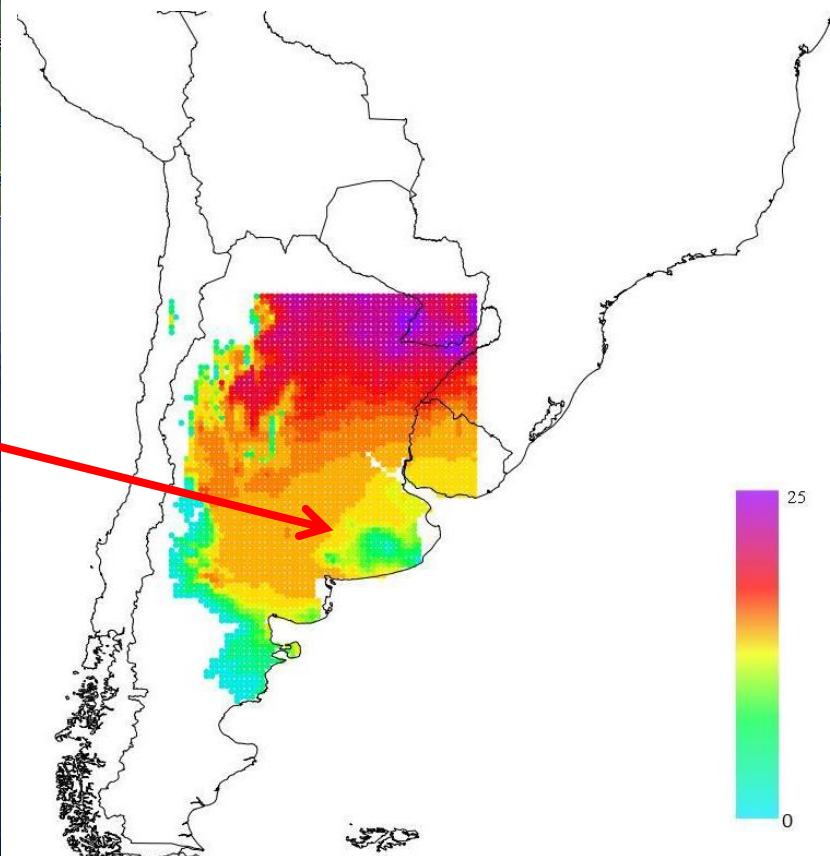
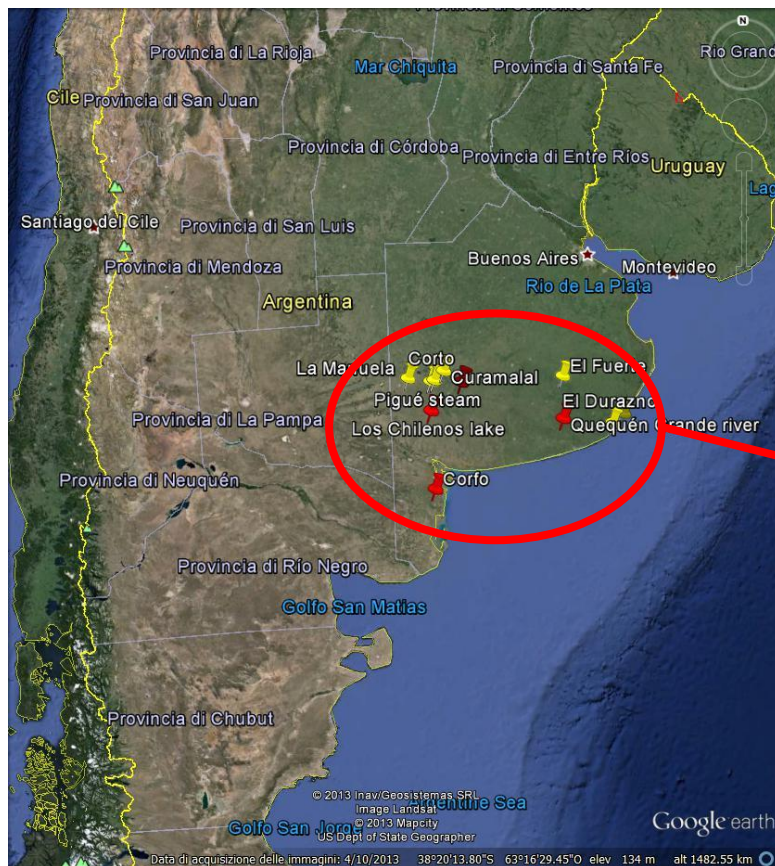
Temperature-dependent survival functions



Temperature and age-dependent fecundity rate functions

THE *Pomacea* spp. CASE STUDY

■ Model calibration



THE *Pomacea* spp. CASE STUDY

■ Model calibration

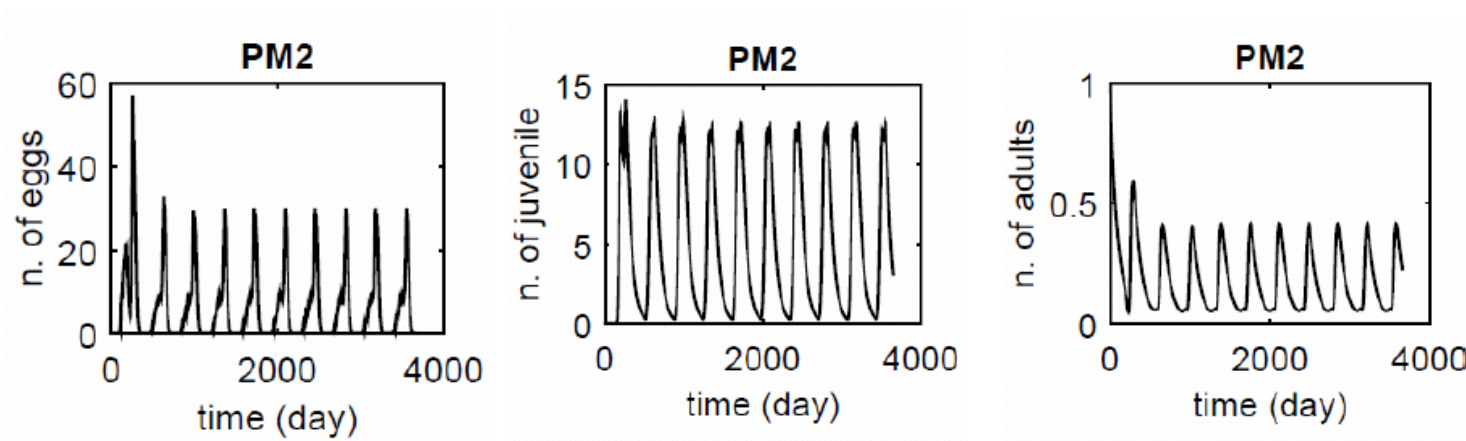
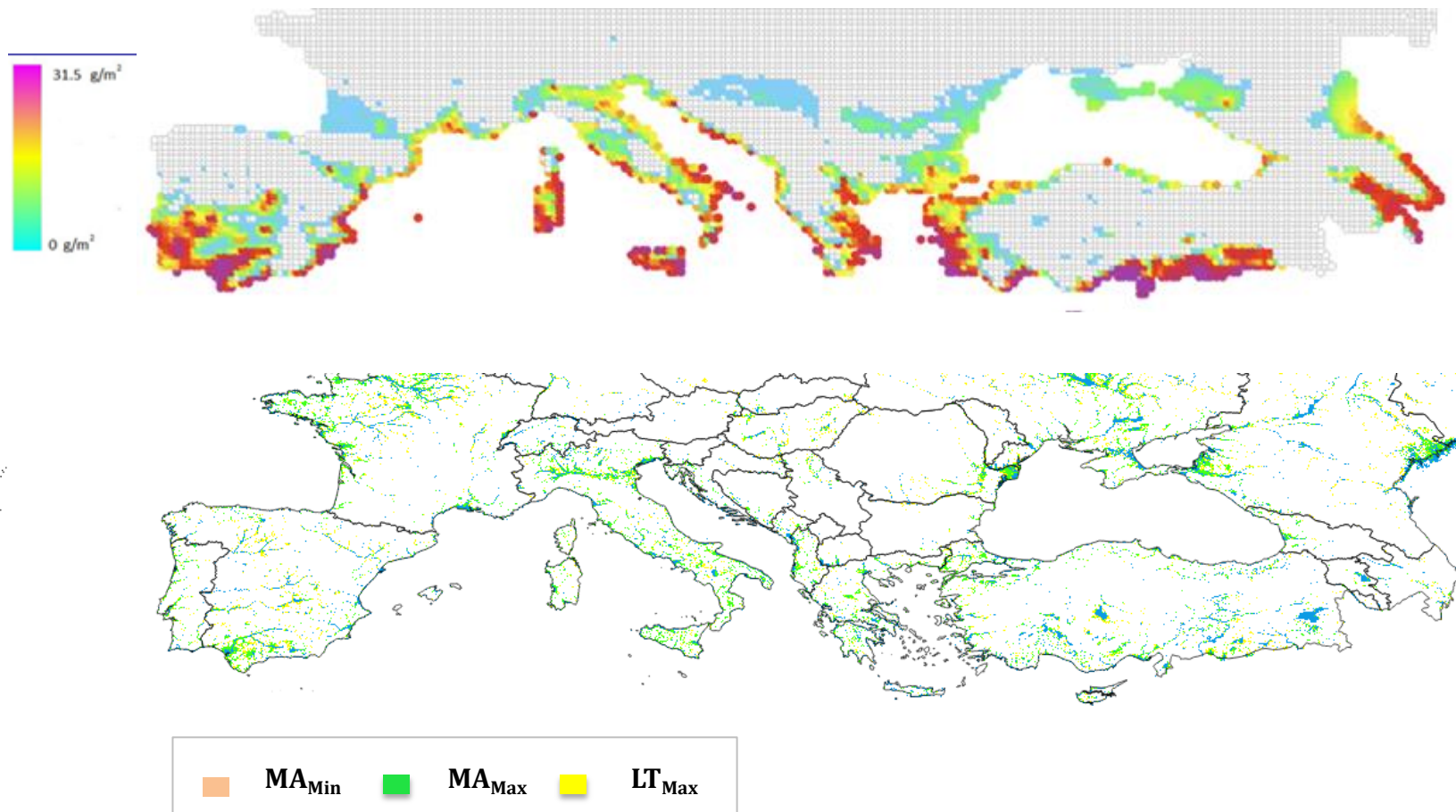


Figure 5: Population dynamics of apple snail obtained with the calibrated model PM2 for the location Kasumigaura ($36^{\circ}06'02.44''\text{N}$ / $140^{\circ}22'38.86''\text{E}$) in Japan.

THE *Pomacea* spp. CASE STUDY

■ *Pomacea* spp. biomass potential distribution





CONCLUSIONS

- Spatially explicit Physiologically-based Demographic Models (PBDMs) are a powerful tool to assess the potential establishment of invasive alien species including plant pests
- They may also include bottom-up effects of plant growth and development on herbivore dynamics and, in some cases, the top-down action of natural enemies
- They provide appropriate information for predicting pest population impact on cultivated plants and the environment at high spatial and temporal resolution
- This modelling approach is also very efficient in generating scenarios supporting decision making and the evaluation of potential establishment and spread of invasive alien species considering climate change



THANK YOU FOR YOUR
ATTENTION !

