Mathematical modelling of insect populations for precision farming practices

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27 June 2024

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PEST FINDER

Funded by the European Union

Luca, who are you?

«An insect guy who plays with numbers»

Applied Mathematics

Entomology

Ph.D

Marie Curie Postdoctoral Fellow

ULB UNIVERSITÉ LIBRE DE BRUXELLES

Control Engineering

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA

Ecological modelling

Applied Entomology

pest contro

MSc

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA

Measurements

BSc

SAPIENZA UNIVERSITÀ DI ROMA

Agronomy

Physics and Astrophysics

Control and Automation

Outline

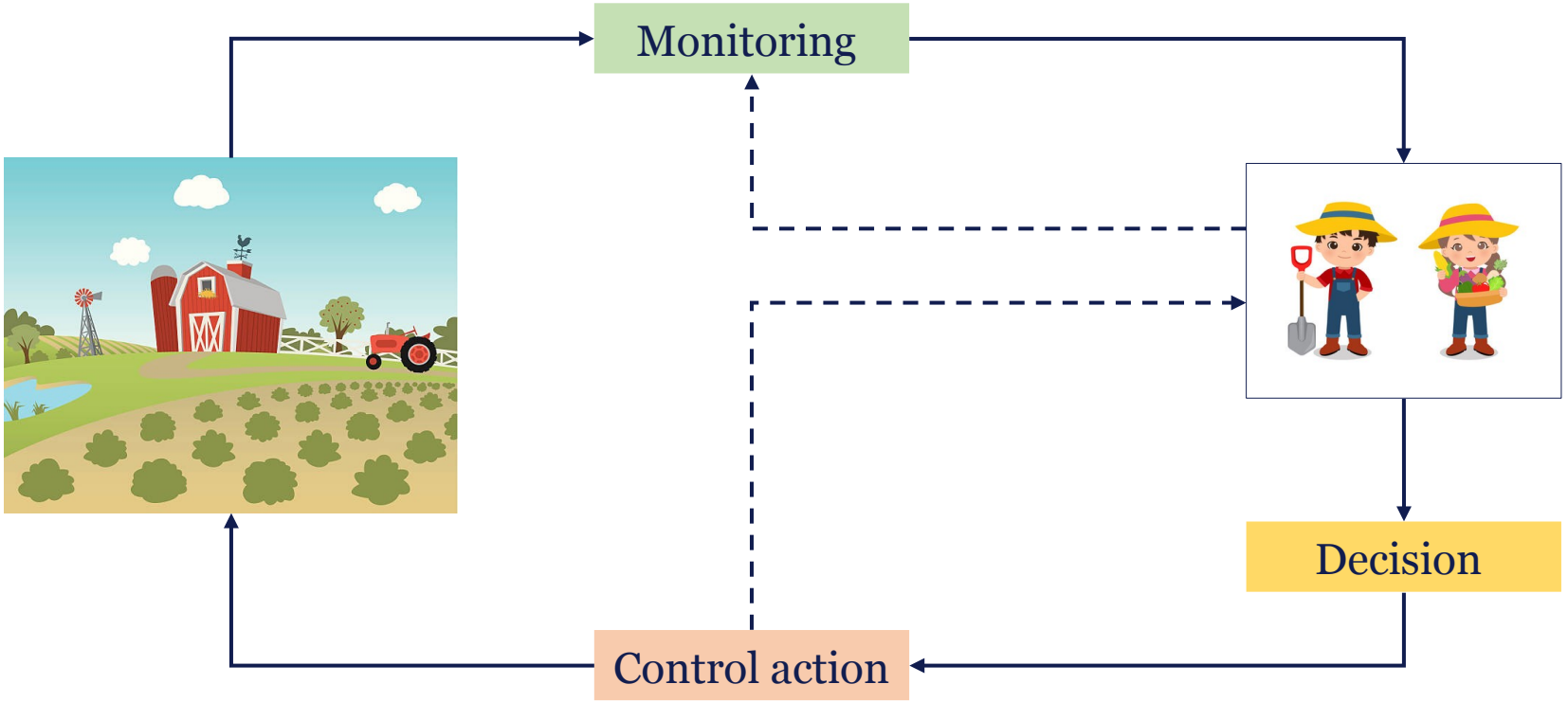
1. Current IPM: common practices and problems

2. Pest population models: past and present

3. Future perspectives

Chapter 1: Current IPM

In a real world, what are we doing in IPM?



Controlling insect pests

One common denominator:

Effective only on certain life stages!

Alternative methods

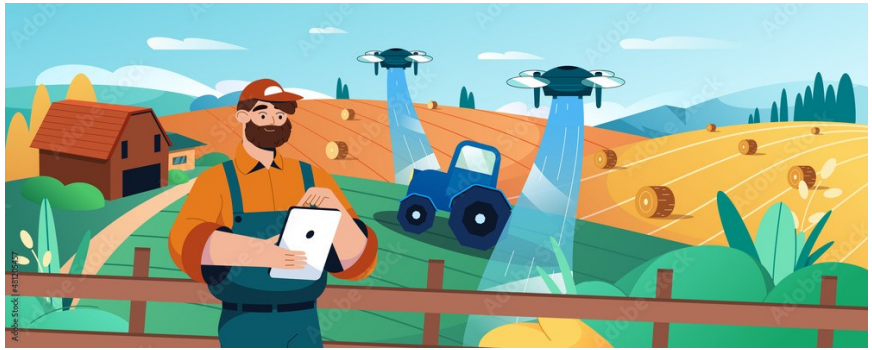
Agronomic practices

Parasitoids

Predators

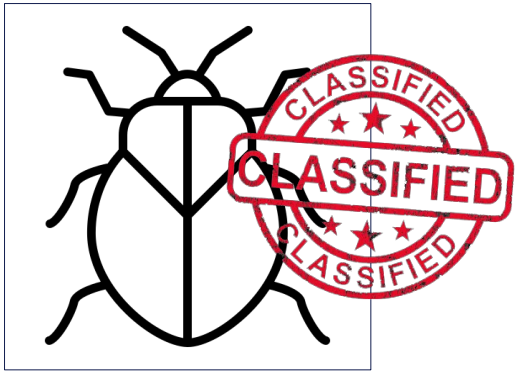
Entomopathogenic fungi

Entomopathogenic bacteria



Chapter 2: Insect population models

What is an insect?



Legs: 3 pairs

Wings: 0, 1, or 2 pairs

Antennae: 2

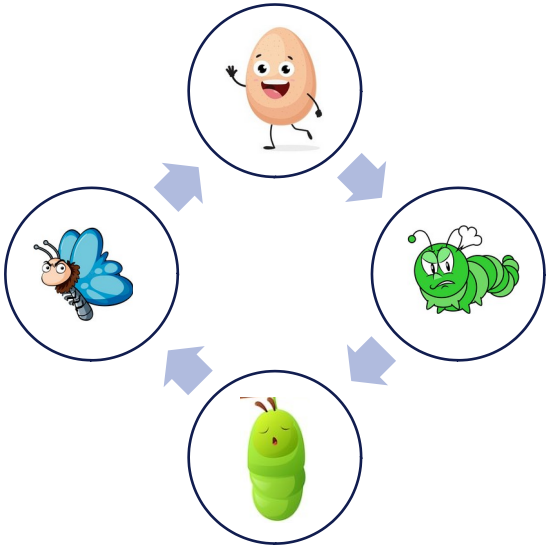
Body segments: 3

Insectkit

- Insects are *ectotherms*
- Their life cycle is divided in stages
- Life stages can be identified

Distinguishing marks:

- Not all the species are pests!

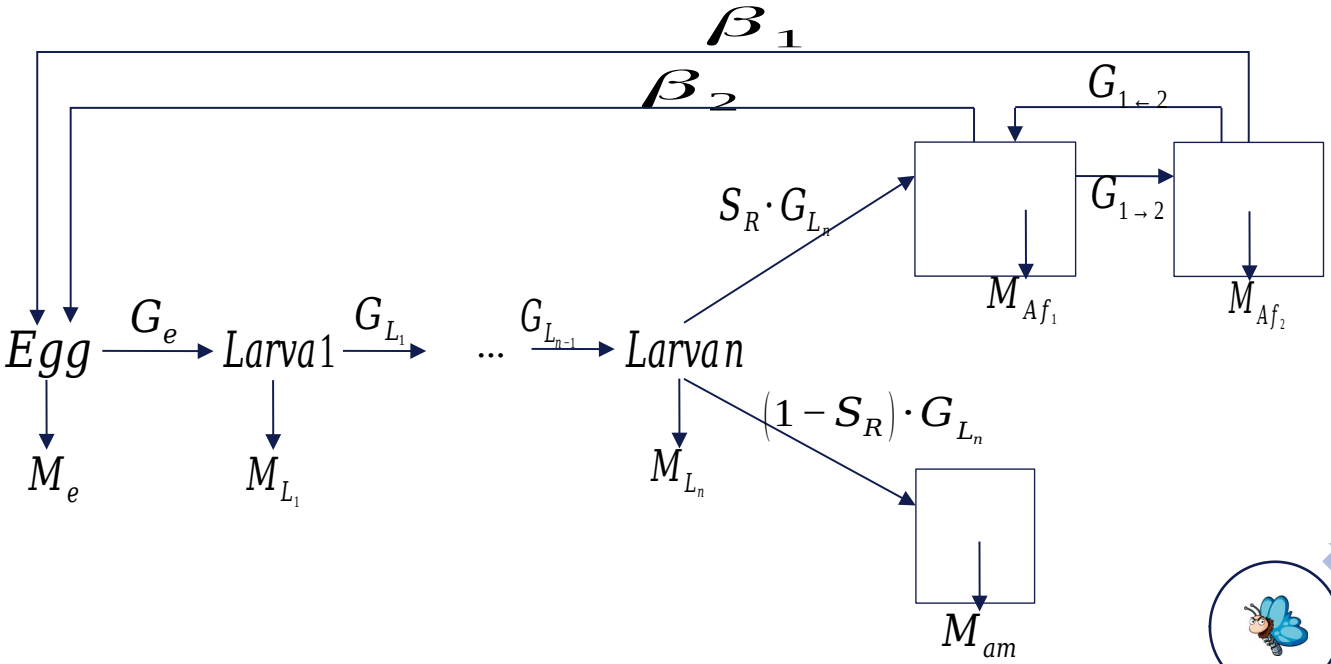


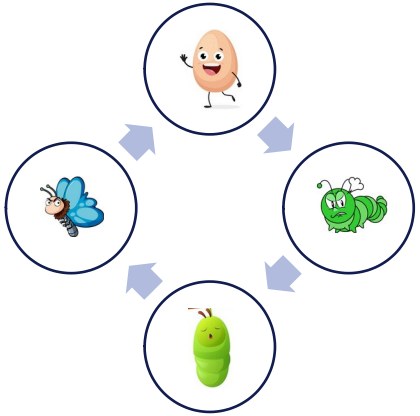
What is an insect?

Different sizes

Different shapes

Modelling insects

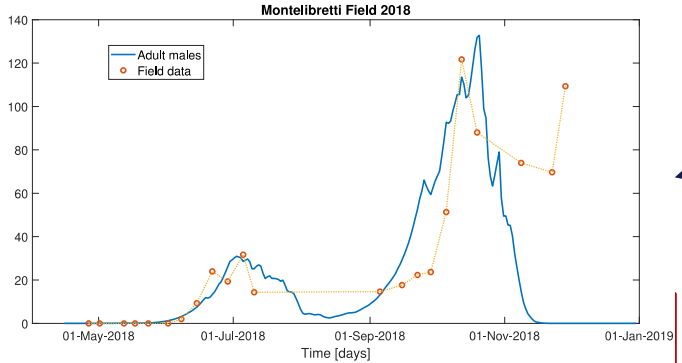




From the insectkit, to the model:

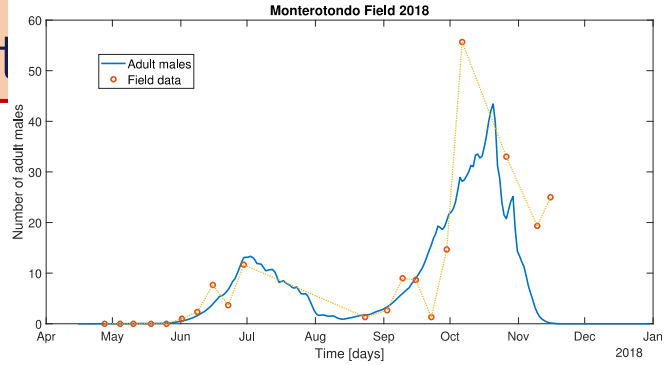
- Each compartment is an identifiable life stage
- The flux of individuals depends on environmental and biological factors

Modelling insects



- Insect

Drosophila suzukii



Ecological Modelling 456 (2021) 109673

Contents lists available at ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel

A general ODE-based model to describe the physiological age structure of ectotherms: Description and application to *Drosophila suzukii*

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ARTICLE INFO

Keywords:
Integrated Pest Management
Physiologically based models
Linear time-varying systems

ABSTRACT

This paper introduces a novel general model based on Ordinary Differential Equations (ODEs) which is able to describe the population dynamics of a large class of insect pests. The proposed model is a physiologically-inspired generalization of a number of *ad hoc* models presented through the years in the literature. Its main

https://doi.org/10.1016/j.ecolmodel.2021.109673

agronomy

Article

A Physiologically Based ODE Model for an Old Pest: Modeling Life Cycle and Population Dynamics of *Bactrocera oleae* (Rossi)

Luca Rossini [1,*], Octavio Augusto Bruzzone [2], Mario Contarini [1,*], Livio Bufacchi [1] and Stefano Speranza [1]

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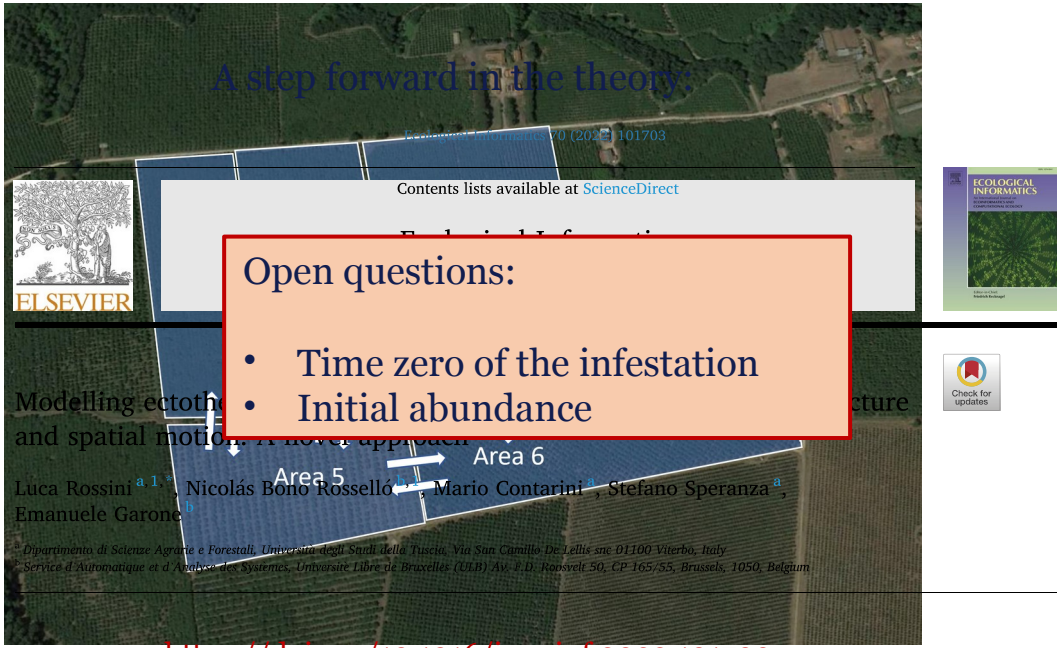
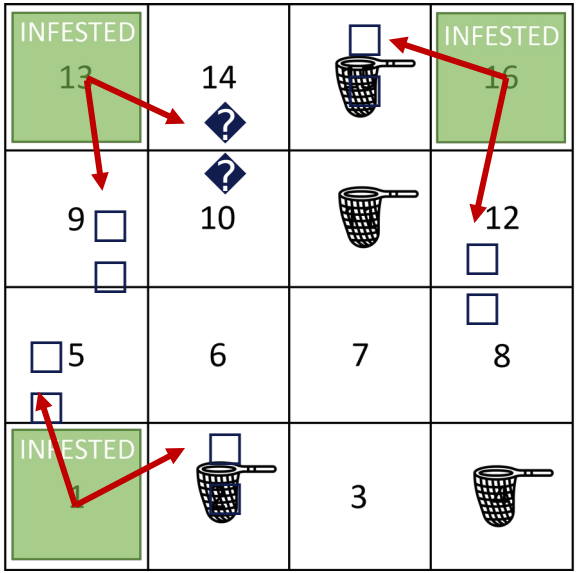
https://doi.org/13.3390/agronomy12102298

Modelling insects: they also move!



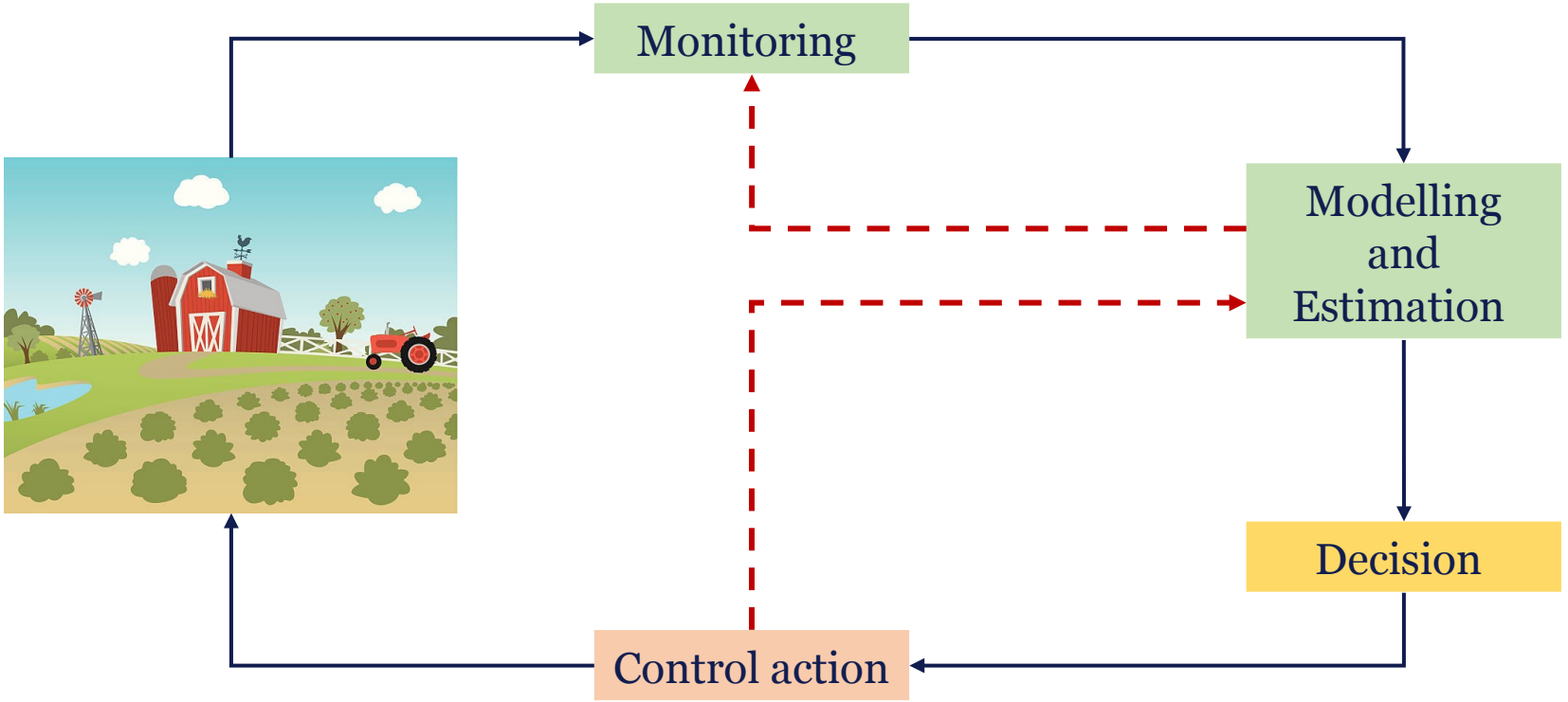
https://doi.org/10.1016/j.ecoinf.2022.101703

Neighbouring fields in a real case



Neighbouring fields according to the model

In a real world, what are we going to do in IPM?



Chapter 3: Future perspectives

Modelling insect pests: from description to prediction

Limitations:

- Models only describe phenomena
- Open loop simulations make bad predictions
- Open field means open populations!

Hint:

- Measurements are rudimental, but helpful
- Data can update model estimations

Task:

- Revise the model to include noise
- Build a model-base

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Modelling and measurements: Project *PestFinder*

PEST FINDER
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Grant n. 101102281

Research Fellow: Luca Rossini, PhD

Project: Model-based estimation and control of agricultural infestation through abiotic changes.

Grant: 101102281

Type: MSCA – Postdoctoral Fellowship

Host Institution: Université Libre de Bruxelles

Department: Control Engineering and System Analysis

Ongoing activities

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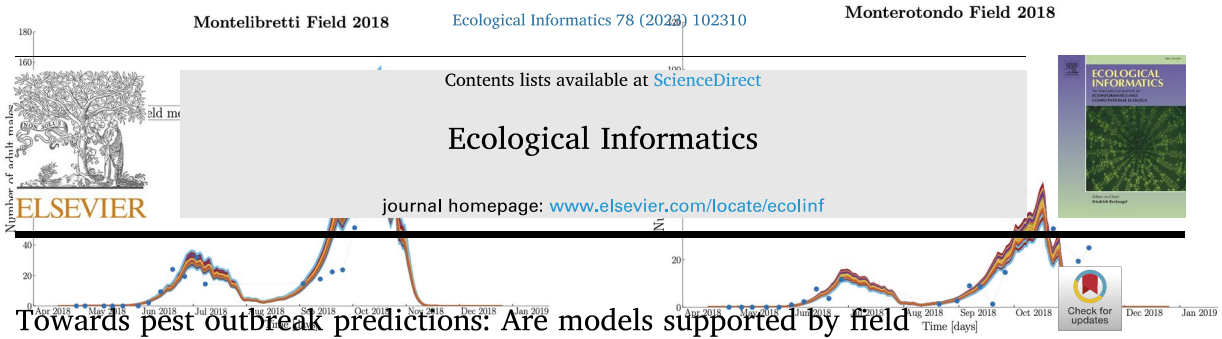
Extended Kalman Filter… and *Drosophila suzukii*!



Ecological Informatics 78 (2023) 102310

Contents lists available at ScienceDirect

Ecological Informatics

journal homepage: www.elsevier.com/locate/ecolinf

Towards pest outbreak predictions: Are models supported by field monitoring the new hope?

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https://doi.org/10.1016/j.ecoinf.2023.102310

Two step algorithm:

- Prediction
- Correction

Result:

- More precise model estimations
- Lower dependency on initial conditions

Future perspectives

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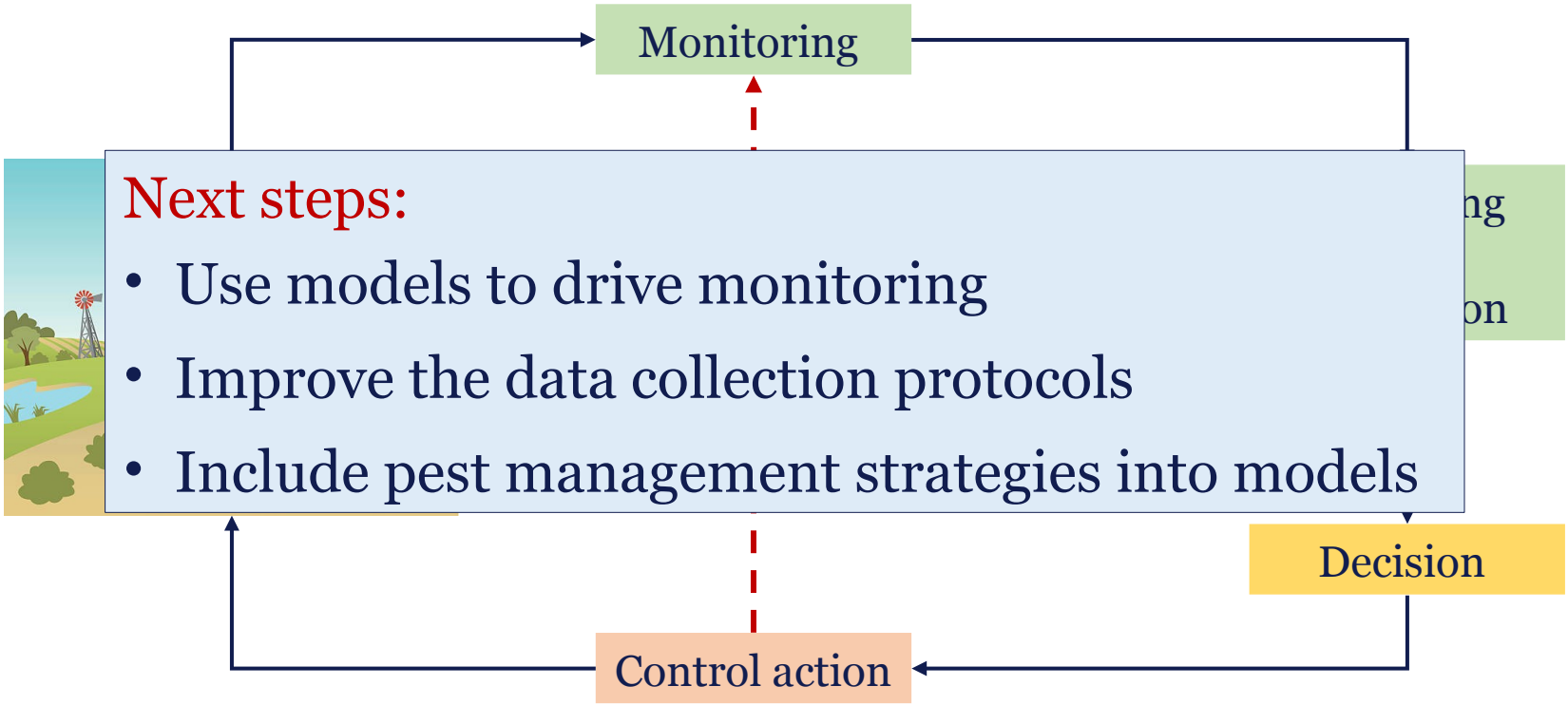

Take home message

Modelling is an essential part of precision agriculture:

- Can support and be supported by new technologies
- Drives decisions on IPM

Multidisciplinary research can improve:

- Measurements
- Model estimations

Our mission:

- Promote the interaction among different fields of research
- Enhance data collection and sharing

- Thank you! -

Funded by the European Union

Grant n. 101102281

More about me:

Google Scholar: https://bit.ly/GScholar-LucaRossini