SEGAE Winter Schoo.

The biodiversity in agroecosystems

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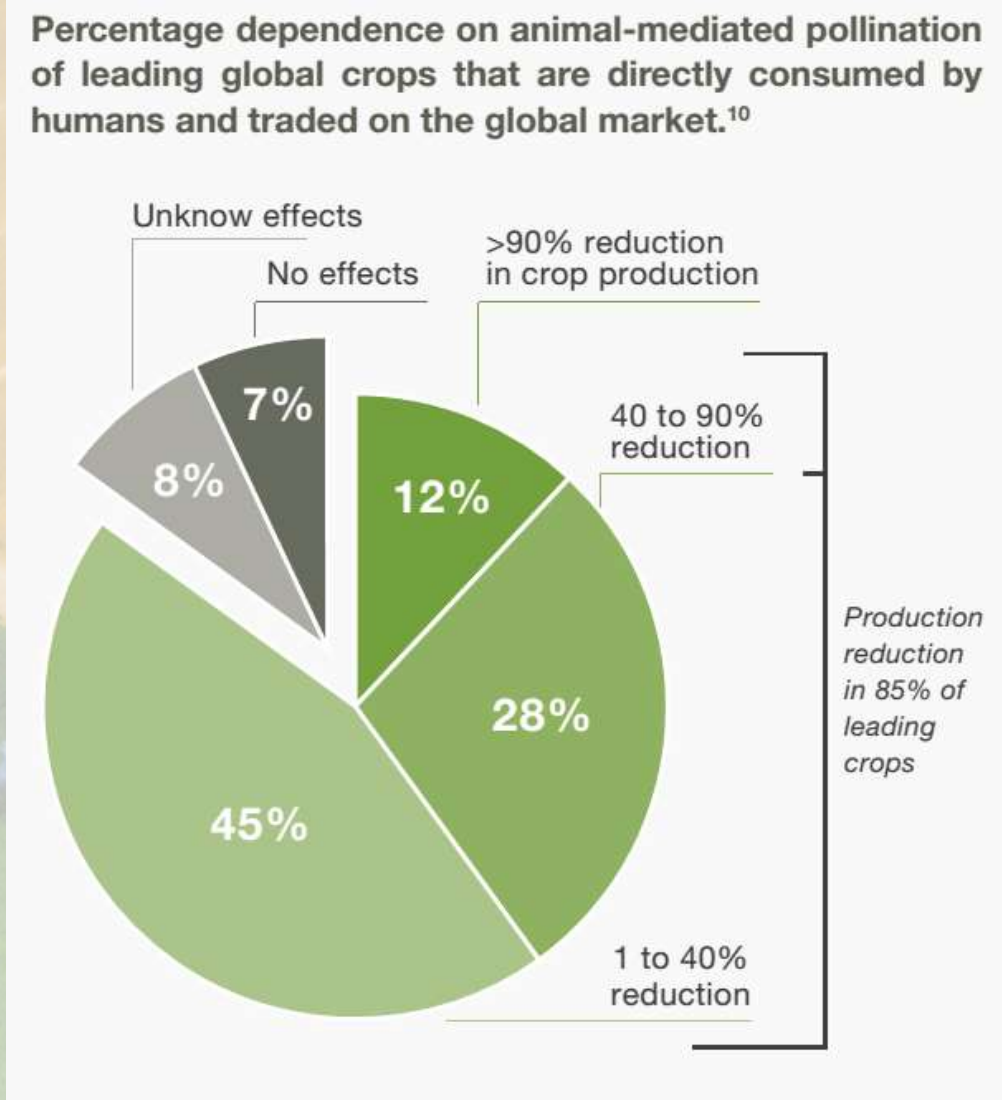
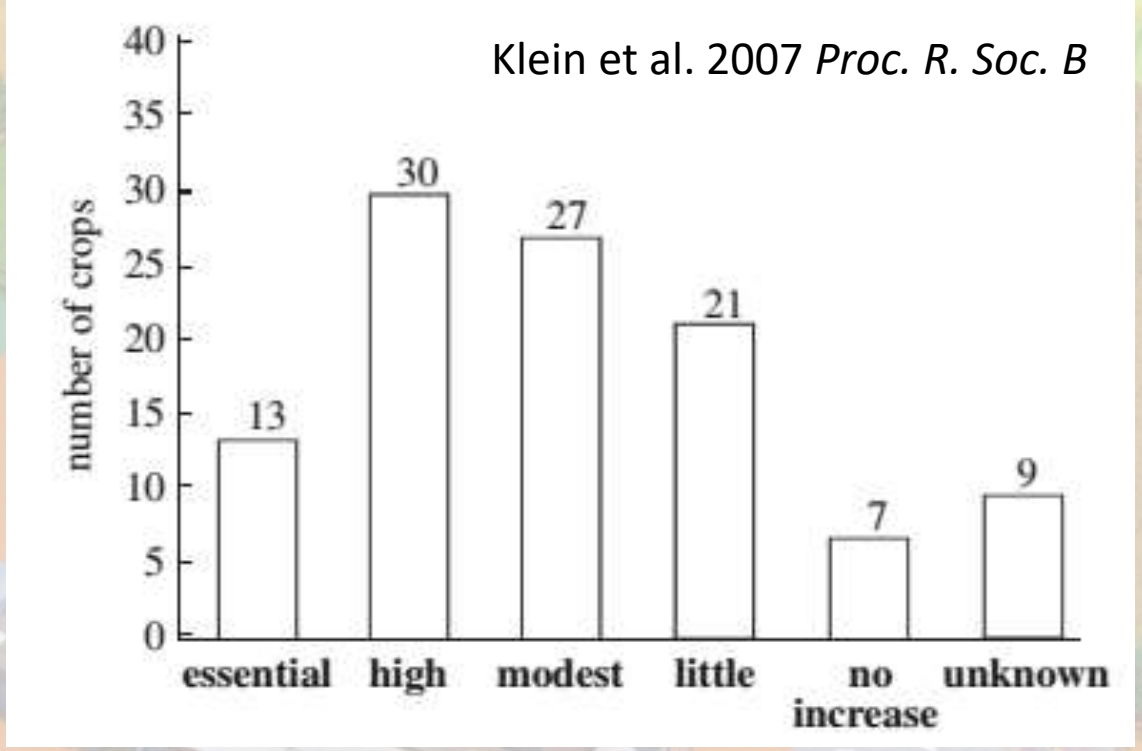
More than one third of the world's crop production is dependent on animal pollination

Pollination





85% of leading crops rely to varying degrees to animal pollination

Pollination

More than 20,000 bee species worldwide

Pollination

Bees

Butterflies

Wasps

Moths

Beetles

Flies

Birds

Bats

Wind

You!

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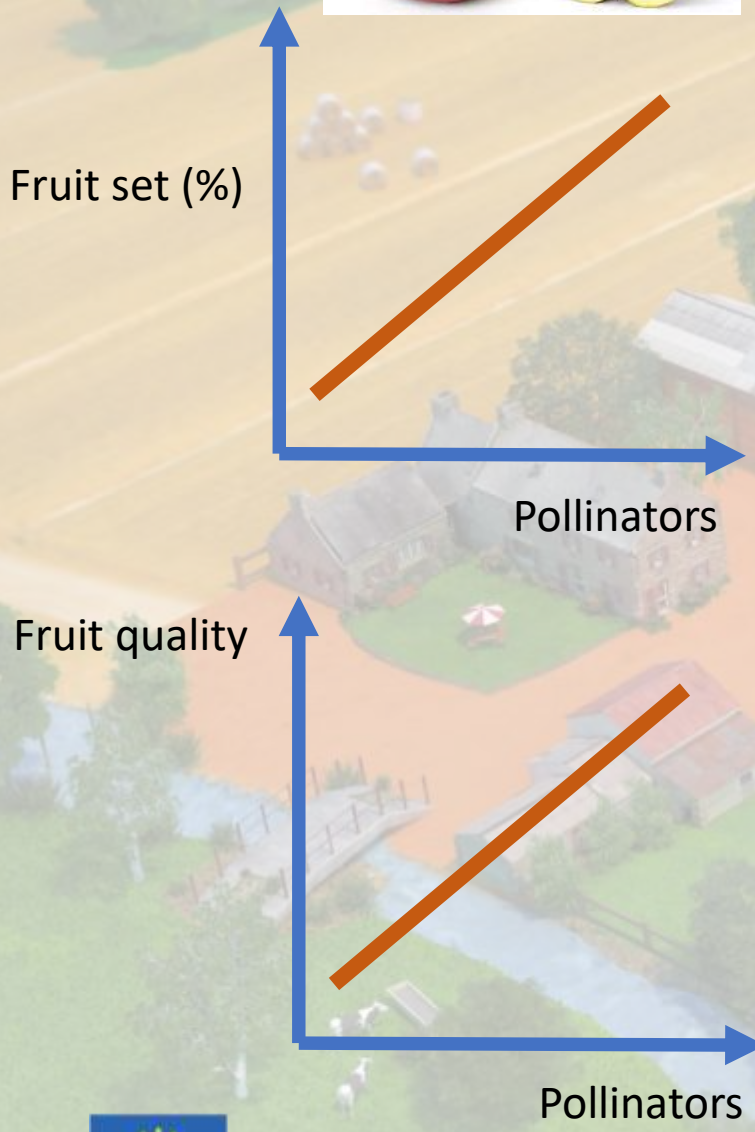
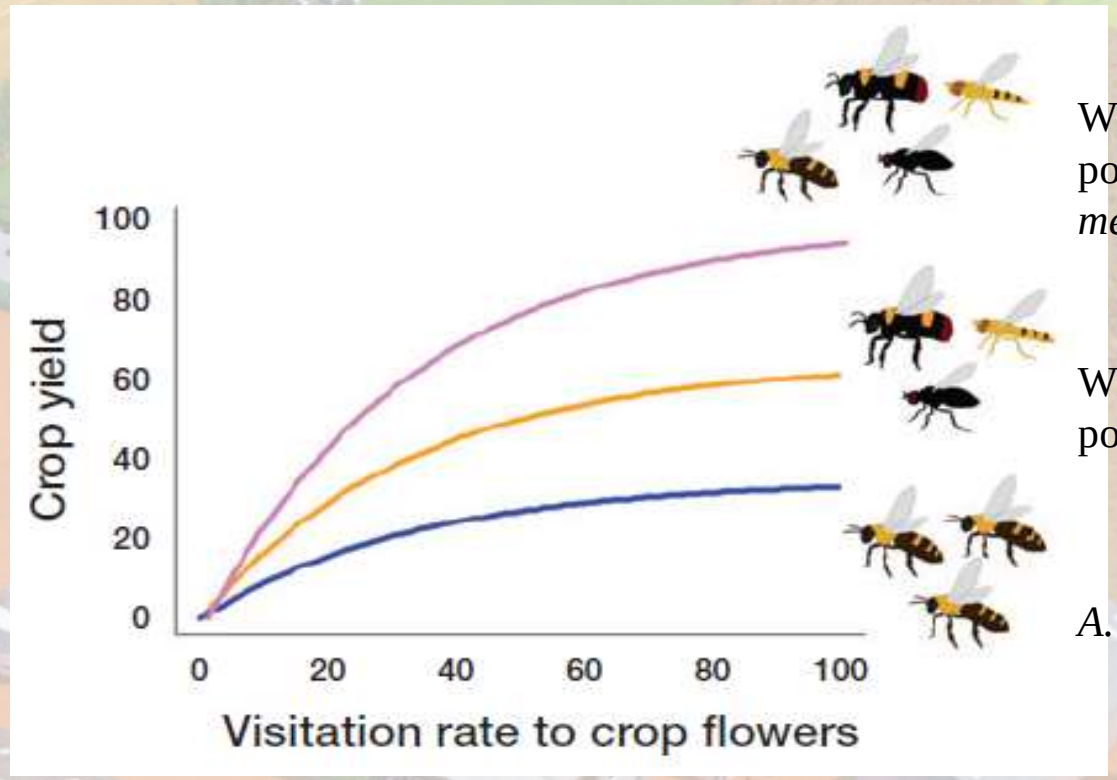
Pollination





Garibaldi et al. (2014). Front. Ecol. Environ, 12(8), 439-447

Biodiversity decline

Colony Collapse Disorder

Half of bee loss cases in USA
First definition: “disappearing disease”
Recently: “Colony Collapse Disorder” (CCD)

In 2006 in US the beekeeper **Dave Hackenberg** reported for the first time a strange phenomenon called CCD which showed a mysterious combination of symptoms:

1. Rapid loss of workers (in collapsed colonies – complete absence)
2. Small cluster of workers and the queen present (in collapsing colonies)
3. Few or no dead bees in hive and in front
4. Worker age inadequate – mostly too young
5. Capped brood present in collapsed colonies
6. Pollen and honey stores intact
7. No robbing, late attack by wax moth
8. IAPV & KBV may be considered the markers of CCD ???

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Biodiversity decline

Colony Collapse Disorder

Is also known as Mary Celeste Syndrome

Mary Celeste was an American merchant brigantine discovered adrift and deserted in the Atlantic Ocean off the Azores Islands on December 4, 1872. It was found plenty of food and water with the captain's and crew's personal belongings undisturbed but no crew members on board and with her lifeboat missing. None of those who had been on board were ever heard from again.

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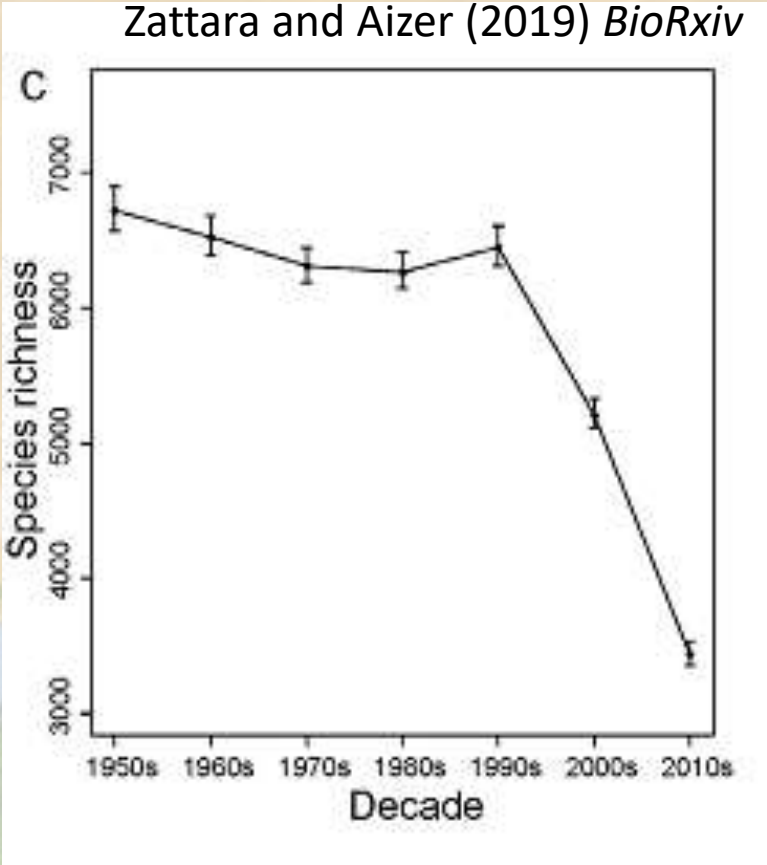
Biodiversity decline: trends

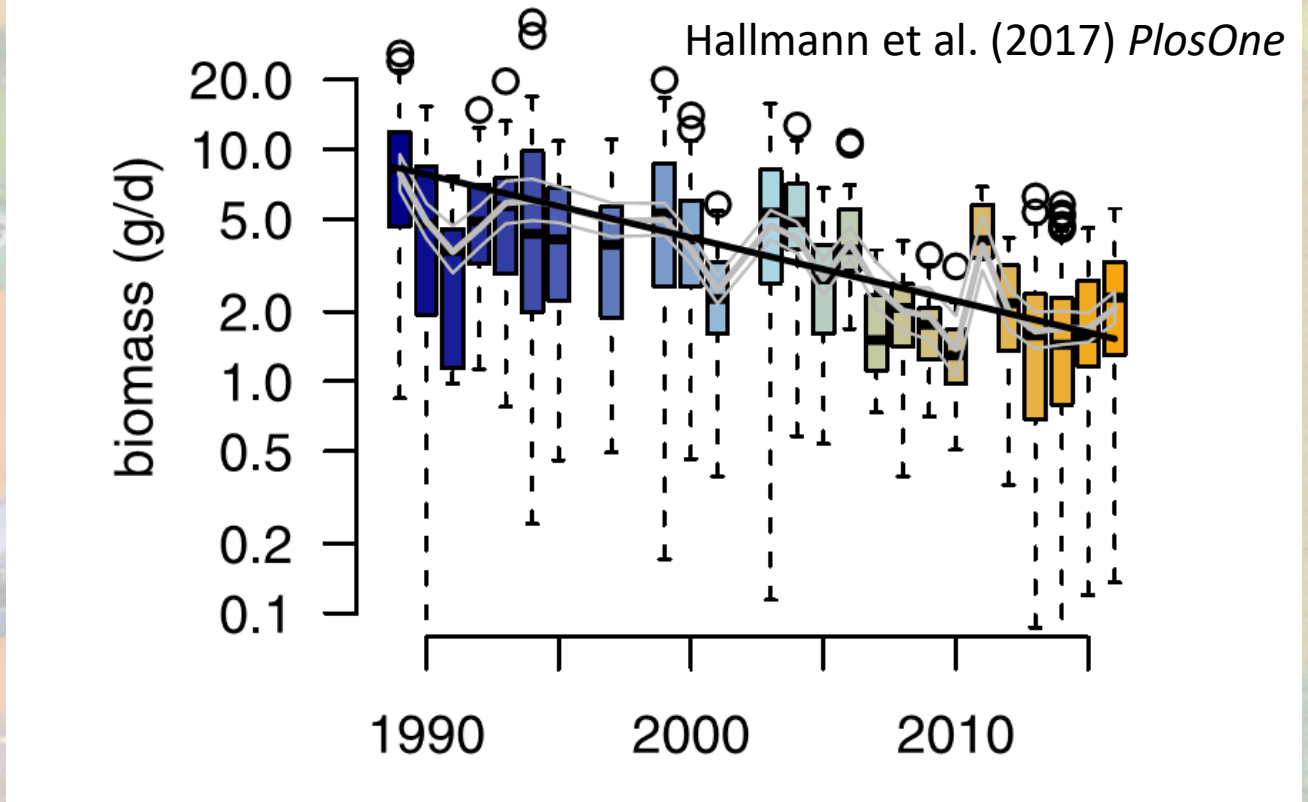
Insect decline

Zattara and Aizer (2019) *BioRxiv*



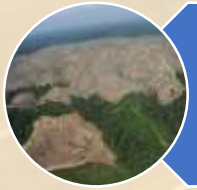
Strong decline in the richness of **wild bee** species in the last 30 years

Hallmann et al. (2017) *PlosOne*



More than 75% of total **flying insect** biomass declined over a period of 27 years

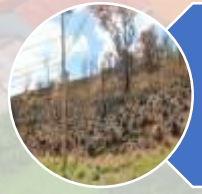
Biodiversity decline: causes



Habitat degradetion

Deforestation

Agricultural intensification



Land-use change

Insecticide use

Main drivers of Insect decline

Wagner (2020) *Annual Review of Entomology*

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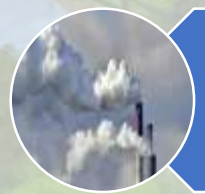
Biodiversity decline: causes

Climate change

Nitrification

Invasive and ornamental species

Light pollution



Elevated Atmospheric Carbon Dioxide Concentrations

Main drivers of Insect decline

Wagner (2020) *Annual Review of Entomology*

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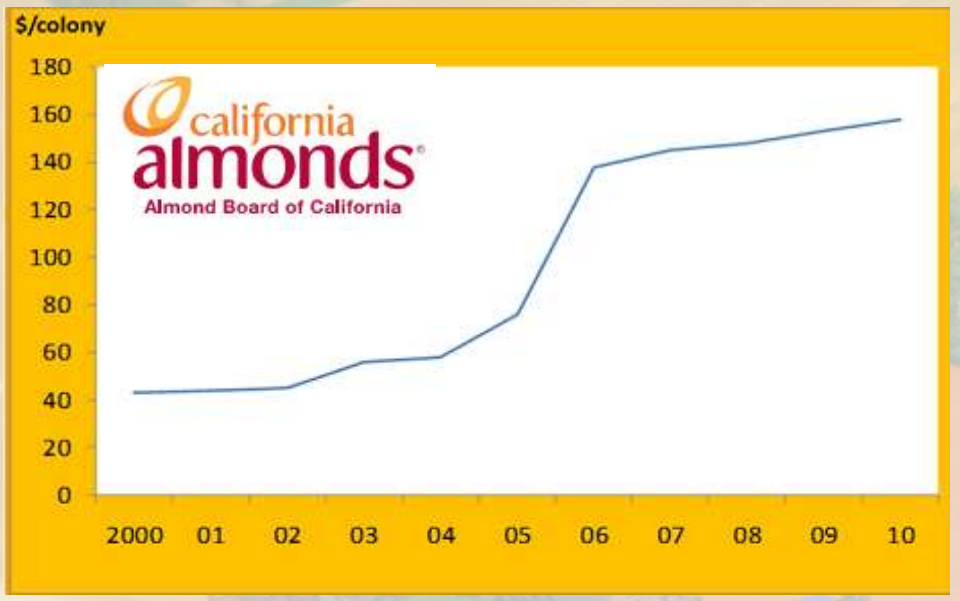
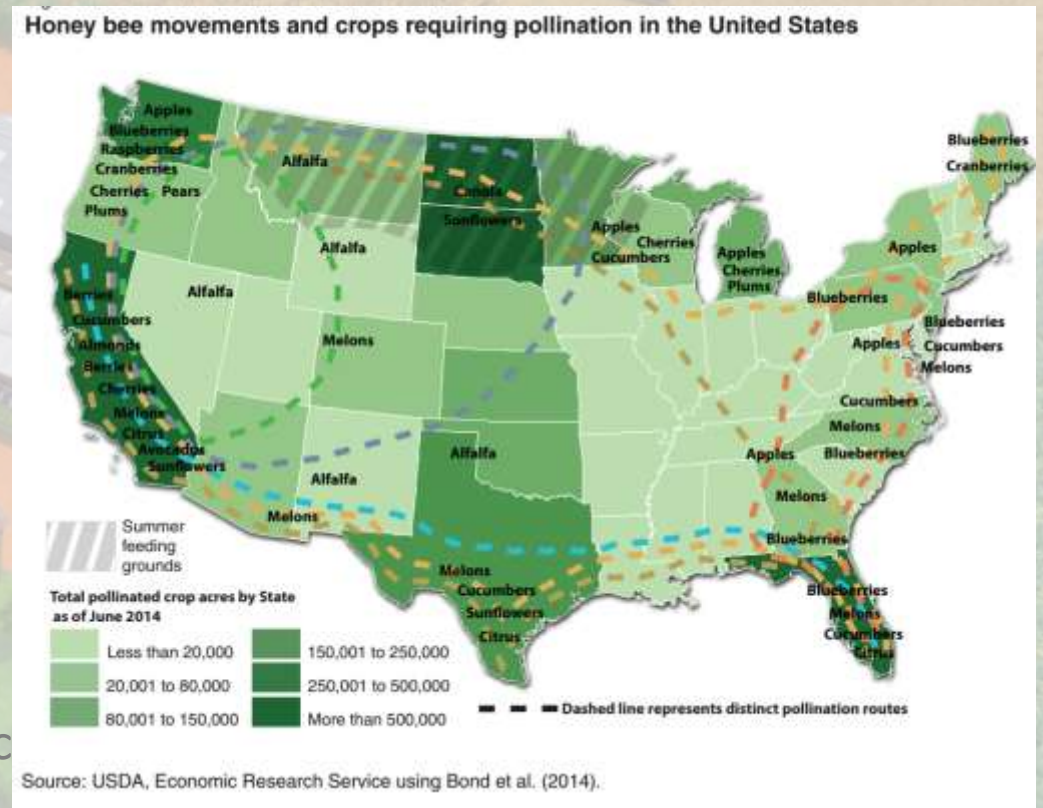
Biodiversity decline: consequences



Ward *et al.* (2010). *American Entomologist*

Consequences of Insect decline

Almond orchard in California: 250,000 ha;
Colony requirement: 5 hives per hectare;
Total number of hives required in California for almond pollination: 1.2 millions;
Total number of hives in USA (2008): 2 millions;

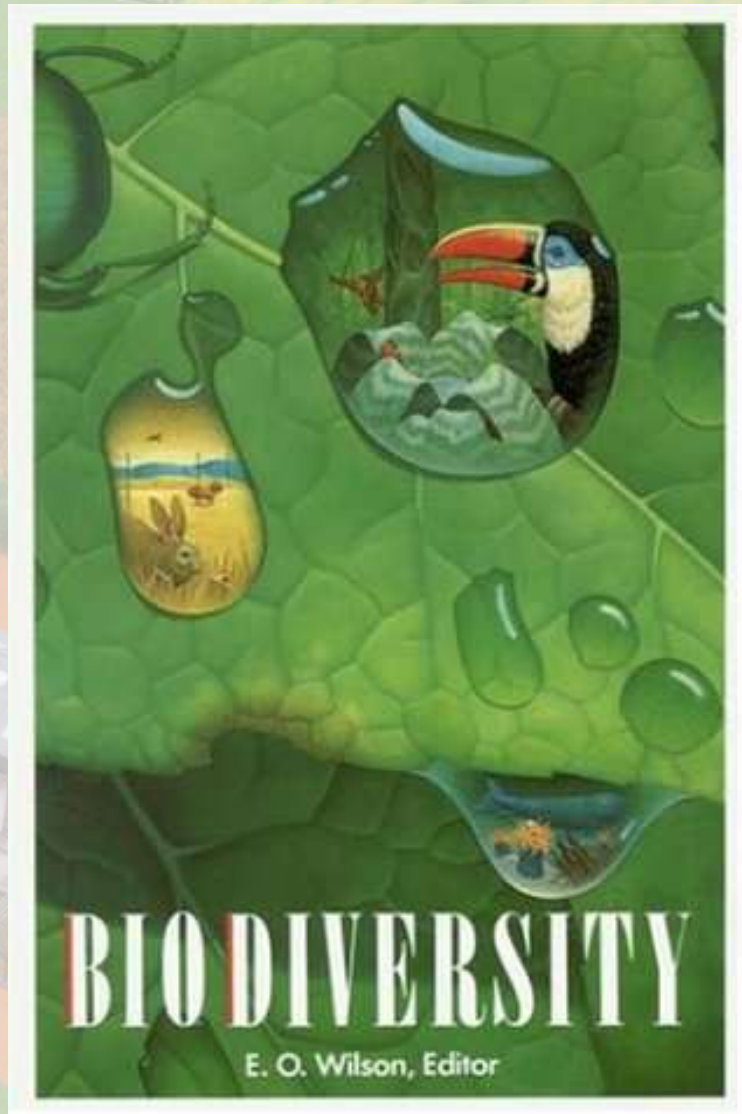


Biodiversity decline: consequences

Consequences of Insect decline

Biodiversity: Definition

The term *Biodiversity* was coined in 1985 for a conference. The proceedings of this conference were the first book on biodiversity: "Biodiversity", E. O. Wilson



Biodiversity: Definition

Biodiversity is the variability among living organisms from all sources, including terrestrial, marine, and other acquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems

Biodiversity: Definition

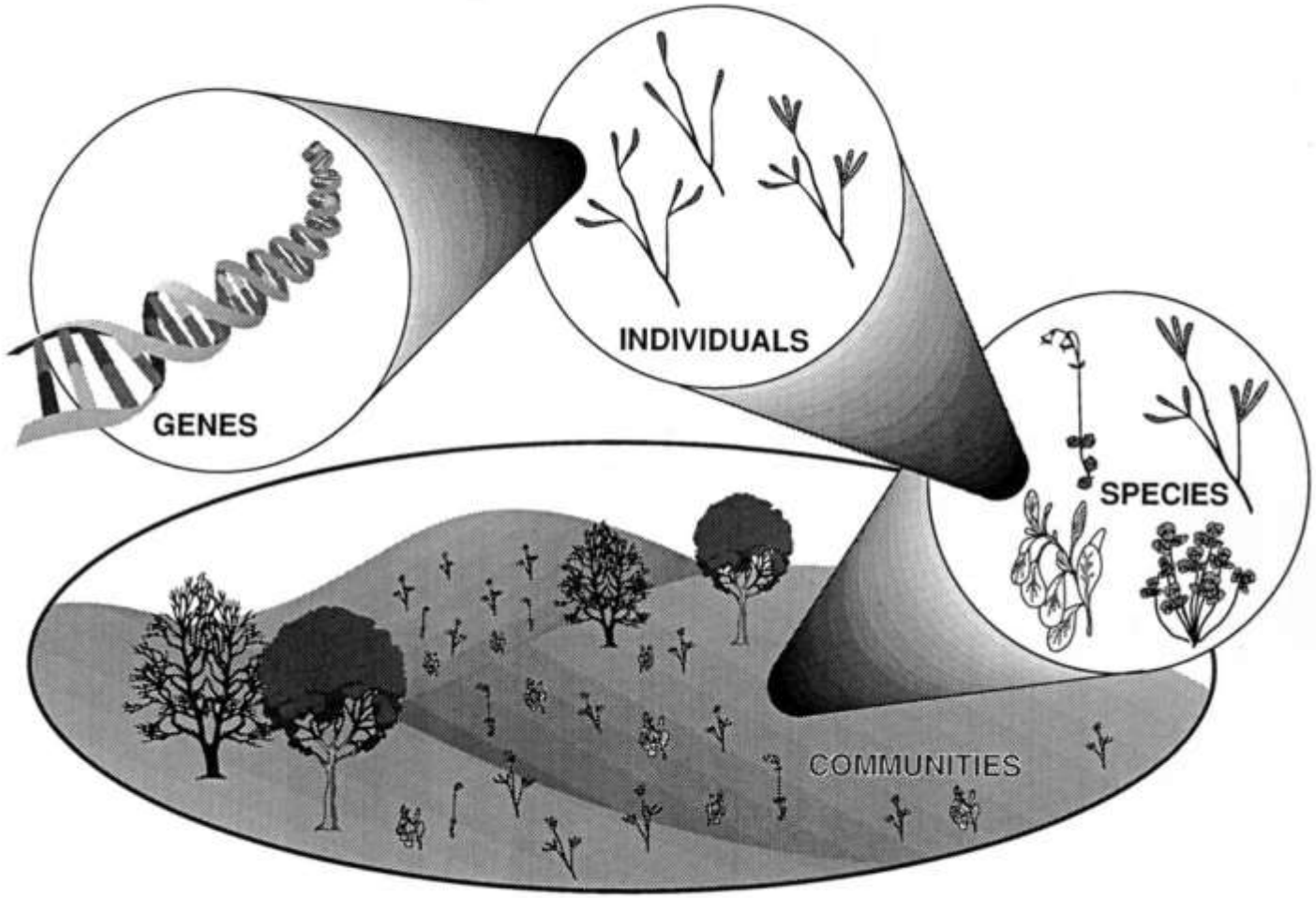
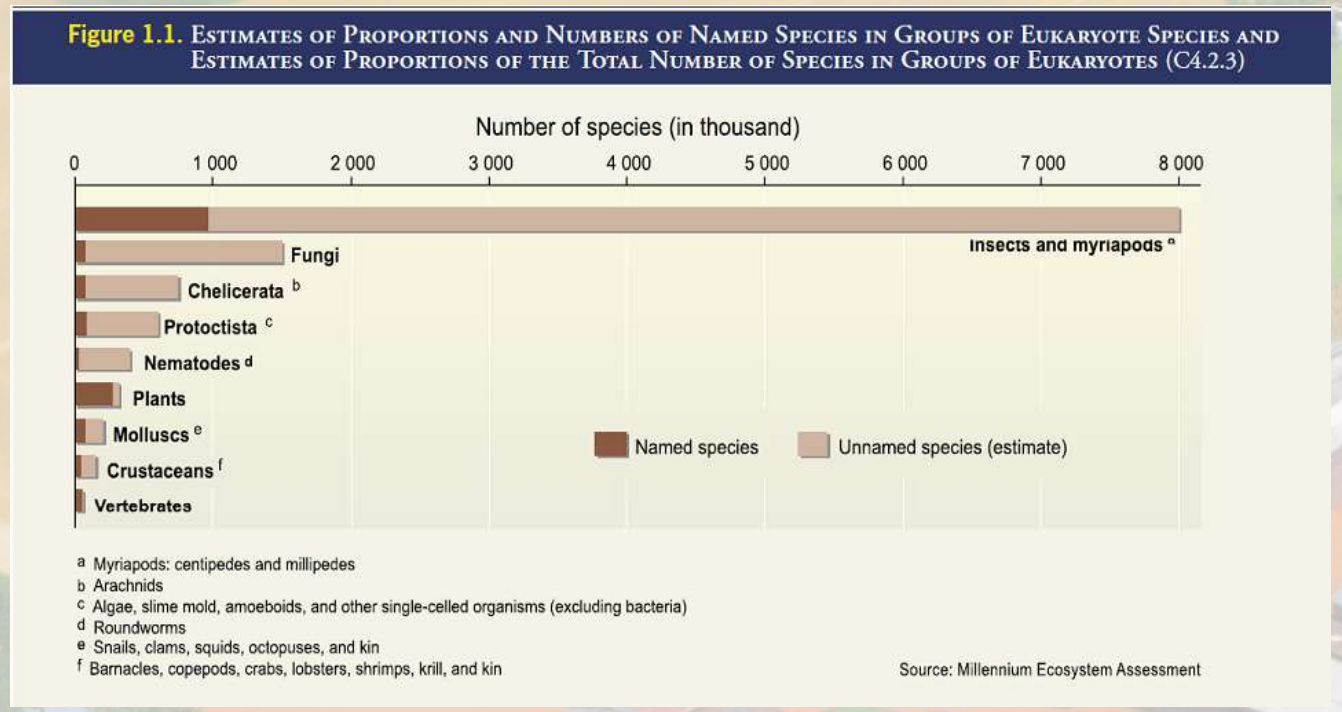
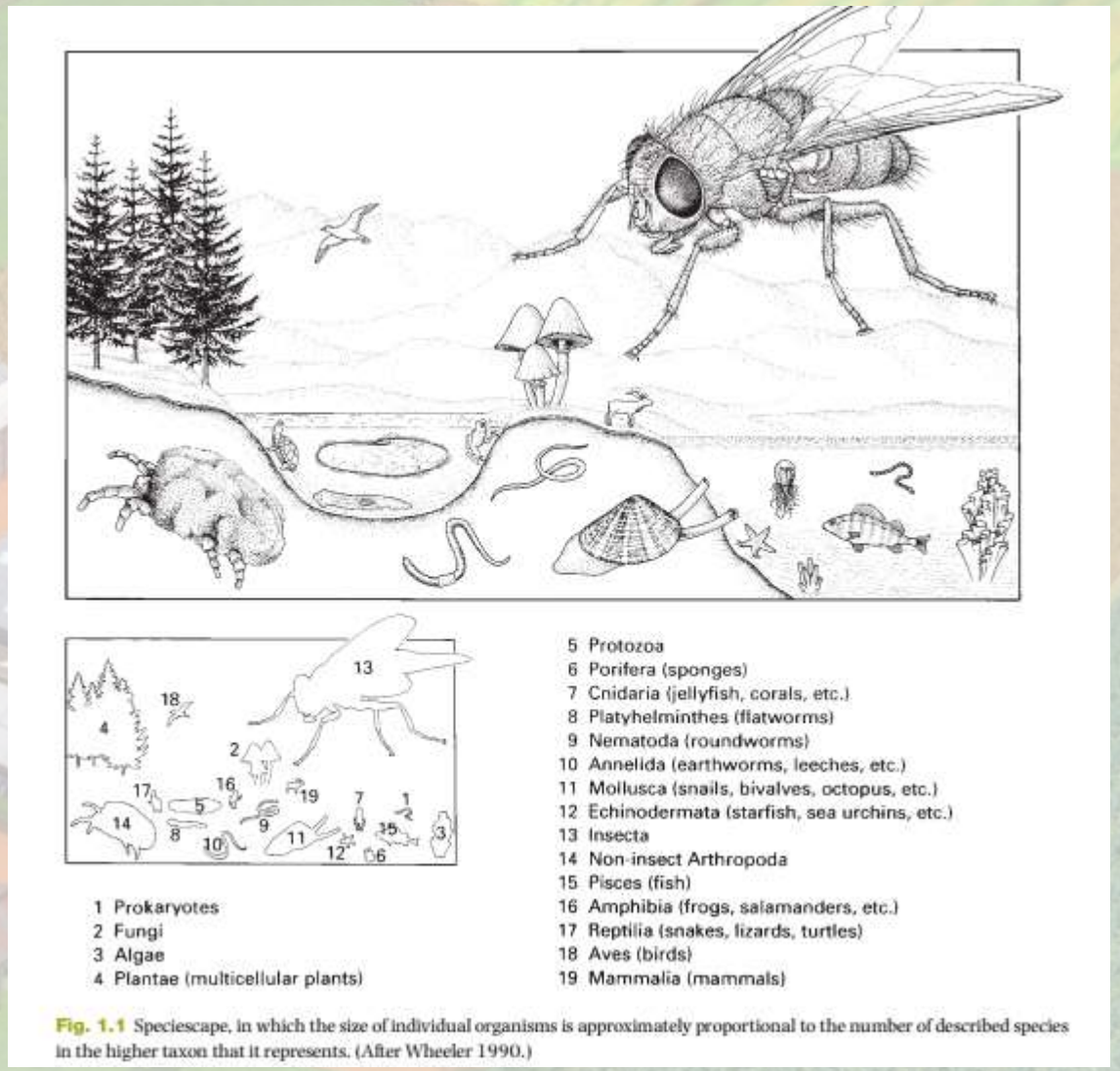


Figure 1.1. Diversity from the gene to the community.

Biodiversity: The Age of Insects



The number of described species is ca. 1.4 million
but the number of predicted species is ca. 10 million



Biodiversity: Soil organisms

The weight of soil organisms under your feet

Under soil pasture
150 g of invertebrates (earthworms)/m²
= the weight of 2 cows per hectar

260 millions of animals/m²

Under forest soil
under a hiker foot
7 millions of animals
= Switzerland inhabitants

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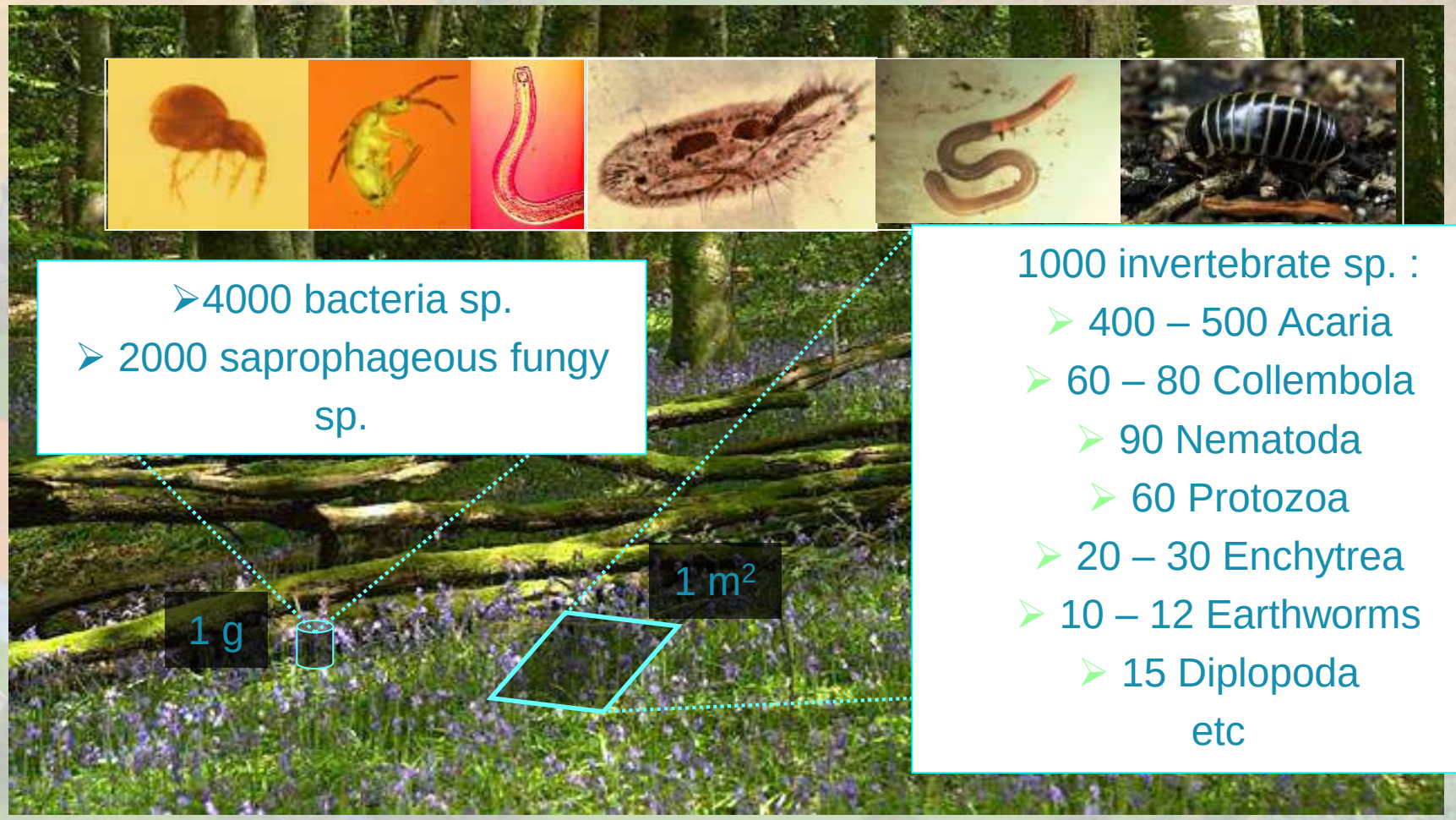
Biodiversity: Soil organisms

Soil organism diversity

- Soil organisms : 25 % of 1.5 million species described all over the world !!
- 90% of soil organisms are still unknown



D'après Decaëns. Torsvick et al. (1994), Hawksworth (2001), Schaefer et Schauermann (1990)

From Biodiversity to Ecosystem services

Soil organisms are linked to 4 main functions in soil

Nutriment recycling

Carbon transformation

Maintenance of soil structure

Pest Regulation

Ecosystem services

(d'après Blanchart, 2012)

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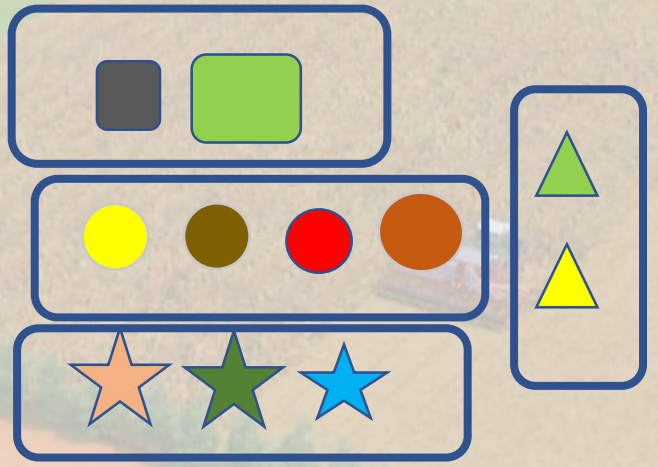
From Biodiversity to Ecosystem services

Biodiversity is the immune system of the planet!

How to measure the importance of the biodiversity?

From Biodiversity to Ecosystem services

Species are grouped based on their specific traits that influence fitness and functioning of ecosystems



The functional biodiversity is "the value and the range of those species and organismal traits that influence ecosystem functioning" (Tilman, 2001).

From Biodiversity to Ecosystem services

*Similarly, several aspects of human well-being depend on benefits provided by ecosystems (the so called **ecosystem services**; Millenium Ecosystem Assessment, 2005).*

Functional diversity = diversity associated to the **ecosystem services** performed by living organisms

NATURE | VOL 387 | 15 MAY 1997

First definition of the Ecosystem services

articles

The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#☆, Shahid Naeem, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶**

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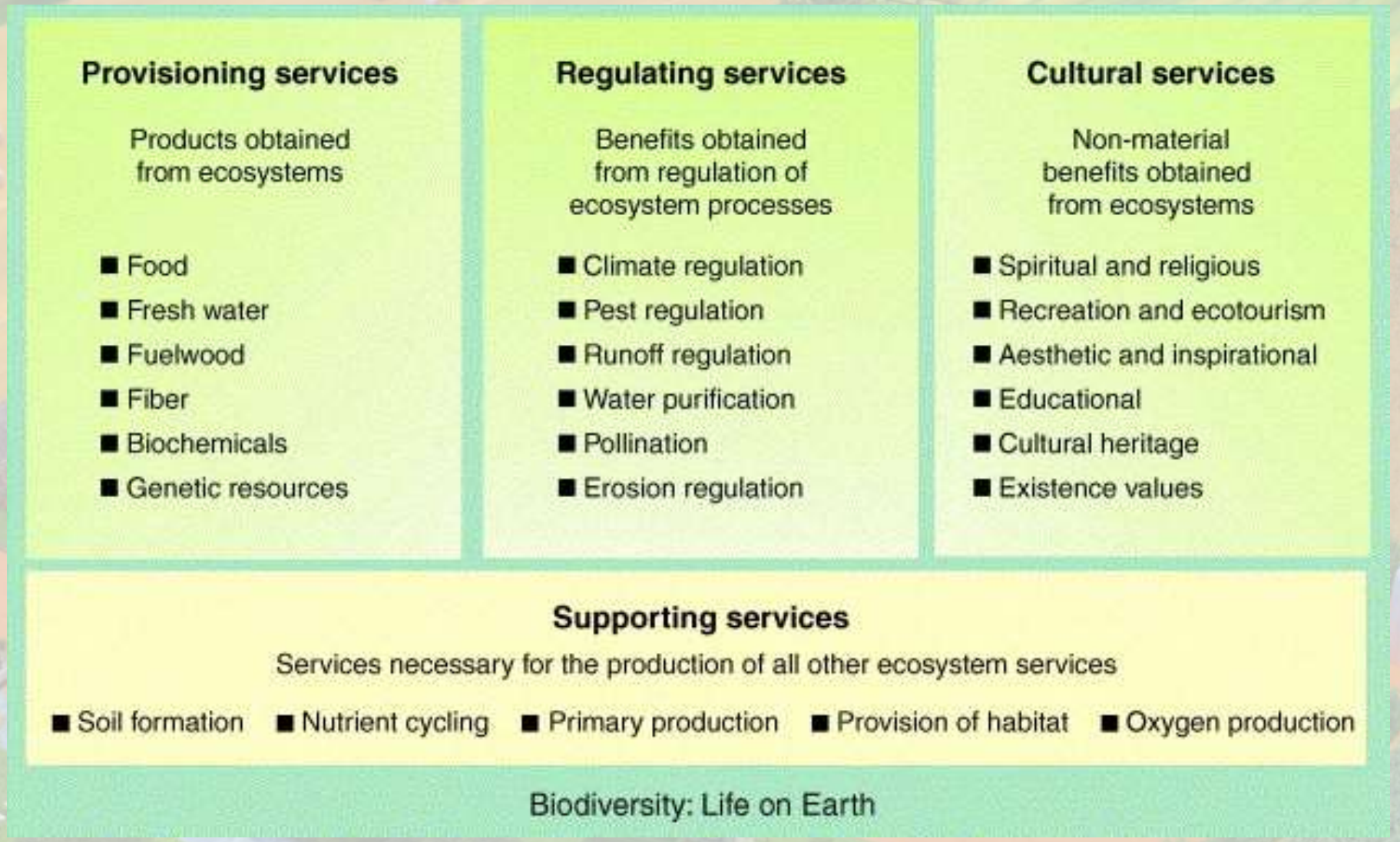
‡‡ *Department of Ecology, Faculty of Agronomy, University of Buenos Aires, Av. San Martin 4453, 1417 Buenos Aires, Argentina*
§§ *Jet Propulsion Laboratory, Pasadena, California 91109, USA*
‖‖ *National Center for Geographic Information and Analysis, Department of Geography, University of California at Santa Barbara, Santa Barbara, California 93106, USA*
¶¶ *Ecological Economics Research and Applications Inc., PO Box 1589, Solomons, Maryland 20688, USA*

The Ecosystem services



Pereira and Cooper (2006). Trends in Ecology & Evolution

The role of biodiversity in agroecosystems

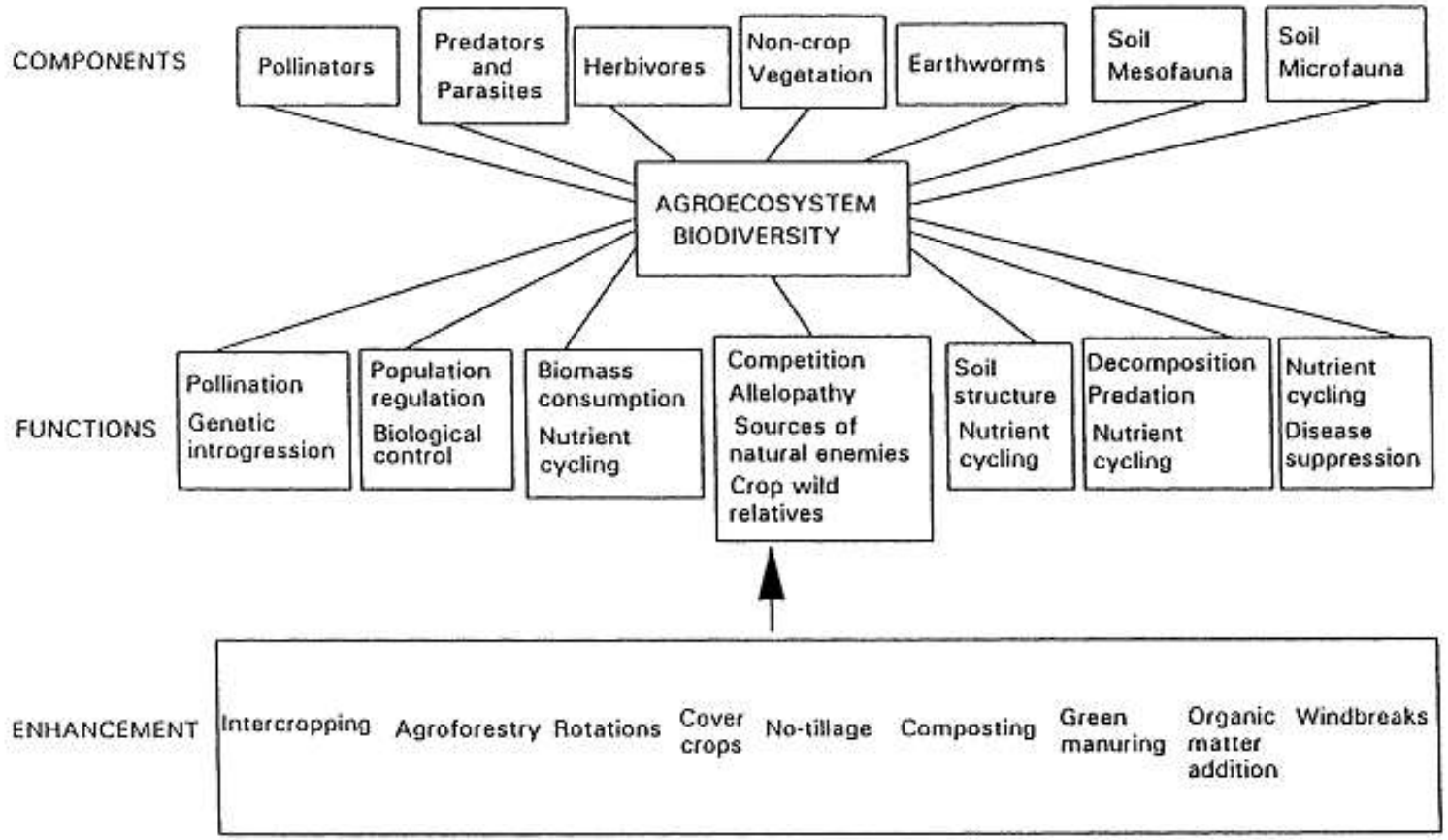


Fig. 1. The components, functions, and enhancement strategies of biodiversity in agroecosystems (Altieri, 1994).

The role of biodiversity in agroecosystems

Soil organisms are linked to ecosystem services

4 groups of ecosystem services provided by soil ecosystem

Millennium Ecosystem Assessment (2005)

Support

Primary Production

O2 Production

Soil formation

Nutrients recycling

Regulation

Air quality

Climat regulation

Control of erosion

Water Purification

Water Regulation

Detoxification

Provisionning

Food and fibers

Genetic resources

Biochemical and pharmaceutical products

Cultural

Culture diversity and religious

Ecotourisme

d'après E. Blanchart, 2012

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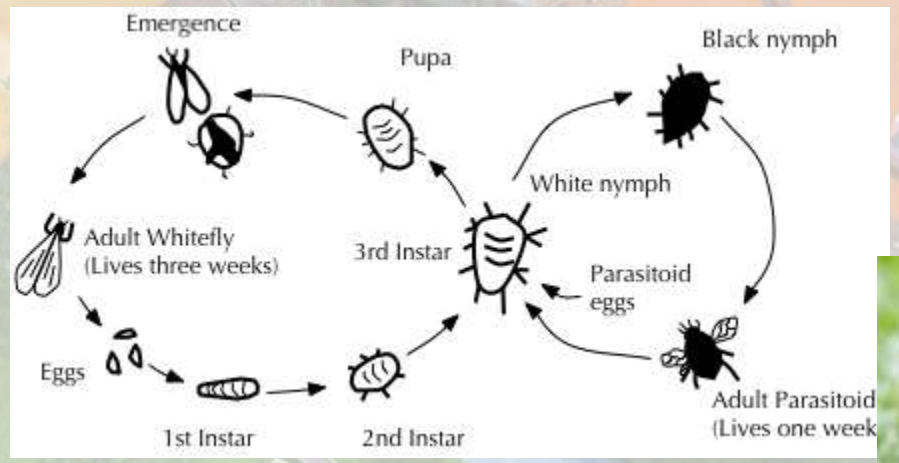
The role of biodiversity in agroecosystems

Pest control

The population of the pests can be regulated by **natural enemies**:

1) **Parasitoids**;
2) **Predators**



Ladybeetle

Larvae of hoverfly

Encarsia formosa

Aphidius colemani

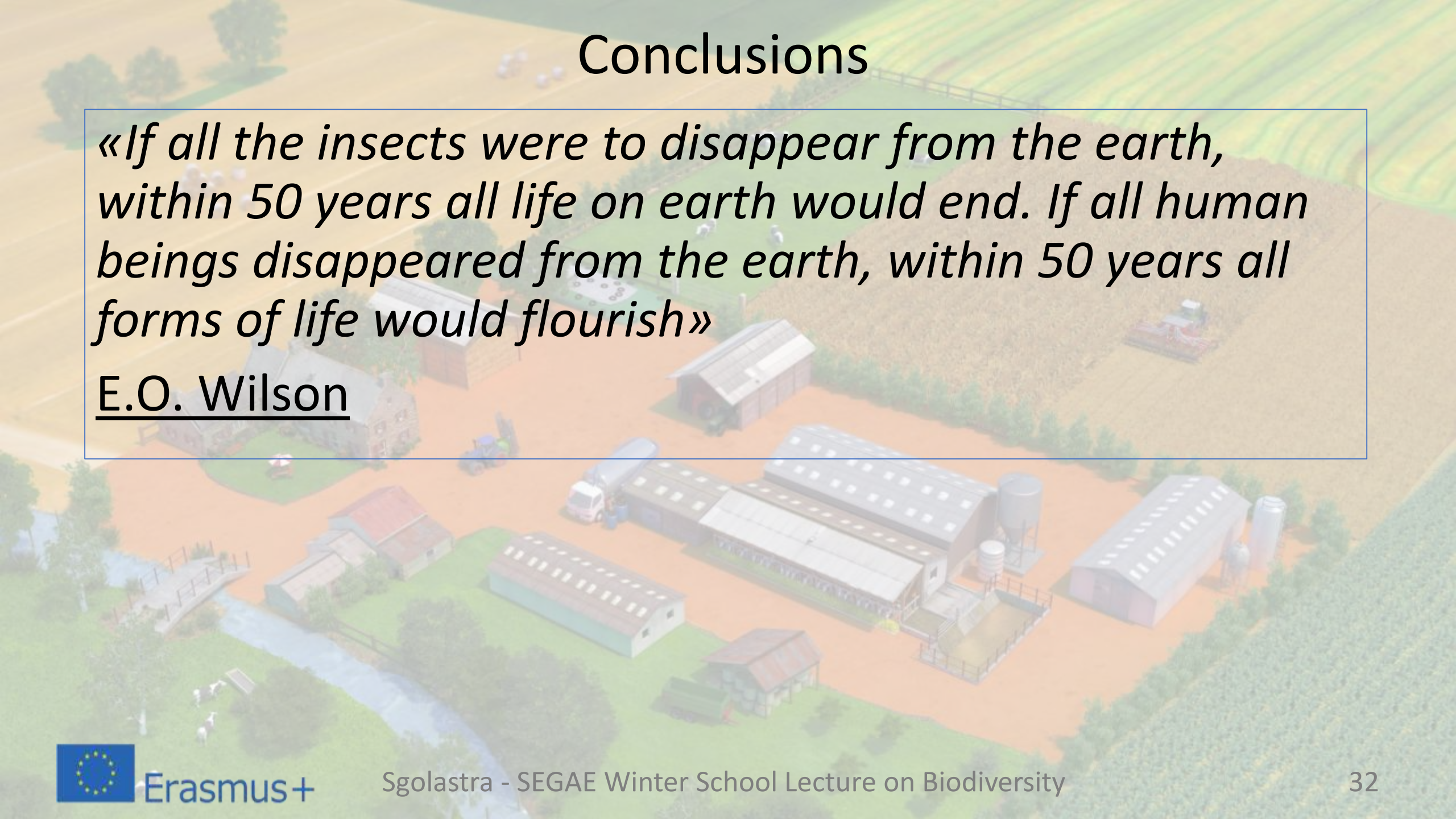
Conclusions

Conclusions

Conclusions

«If all the insects were to disappear from the earth, within 50 years all life on earth would end. If all human beings disappeared from the earth, within 50 years all forms of life would flourish»

E.O. Wilson



Soil fertility and nutrient cycling

Table 1
Influences of soil biota on soil processes in ecosystems (Hendrix et al., 1990)

	Nutrient Cycling	Soil Structure
Microflora (fungi, bacteria, actinomycetes)	Catabolize organic matter; mineralize and immobilize nutrients	Produce organic compounds that bind aggregates; hyphae entangle particles onto aggregates
Microfauna (Acarina, Collembola)	Regulate bacterial and fungal populations; alter nutrient turnover	May affect aggregate structure through interactions with microflora
Mesofauna (Acarina, Collembola, enchytraeids)	Regulate fungal and microfaunal populations; alter nutrient turnover; fragment plant residues	Produce fecal pellets; create biopores; promote humification
Macrofauna (isopods, centipedes, millipedes, earthworms, etc.)	Fragment plant residues; stimulate microbial activity	Mix organic and mineral particles; redistribute organic matter and micro-organisms; create biopores; promote humification; produce fecal pellets