Worldwide Integrated Assessment of the Impact of Systemic Pesticides on Biodiversity and Ecosystems (WIA)

Noa Simon-Delso
simon@cari.be
CARI asbl, Utrecht University, Bee Life

WORLDWIDE INTEGRATED ASSESSMENT

First meta-analysis of the impact of neonicotinoids and fipronil on the environment

Published at *Environmental Science and Pollution Research* 2014, 2015 and 2017

Review of more than 1.200 scientific studies

29 independent scientists from different disciplines and 4 different continents

The Task Force on Systemic Pesticides

CHAPTERS

First set of publications in 2014-2015

- Editorial
- Trends, uses, mode of action and metabolites
- Environmental fate and exposure
- Impacts on invertebrates
- Impacts on vertebrates
- Risks of large-scale use of systemic insecticides to ecosystem functioning and services
- Alternatives to neonicotinoid insecticides for pest control: case studies in agriculture and forestry
- Conclusions

Second set of publications in 2017

- An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 1: new molecules, metabolism, fate, and transport
- An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 2: impacts on organisms and ecosystems
- An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 3: alternatives to systemic insecticides

METHODOLOGY

Objective – Synthesize the state of knowledge on the risk to biodiversity and ecosystem functioning posed by the global use of neonicotinoids and fipronil

Literature research

- Search engines: Web of Science, Google Scholar...
- Search terms:
  - [product] – imidacloprid, clothianidin, thiamethoxam, thiaclopird, acetamiprid, nitempyram, dinoteguran, fipronil, cis-neonicotinoids, sulfoxaflor, neonicotinoid*
  - [taxon] – depending on chapter: vertebrate*, mammal*, bird*, reptile*, amphibian*, fish*, bee*, honeybee*, bumblebee*, earth worm*, diptera...
  - [matrice] – soil, water, plant, air, dust, resin, guttation…
  - Other terms: resistance, ecosystem services, market, use, yield, receptor, solubility…

METHODOLOGY

Result of the literature research:

- Identification of relevant peer reviewed articles

- Not scientific studies (e.g. Industry) and public reports (e.g. EFSA, USEPA, FAO, USDA...) were used as sources in occasions

MAIN FINDINGS

Clear evidence of harm sufficient to trigger regulatory action

Neonics persist for months/years and accumulate

Water soluble and systemic

Toxicity increased by the duration of exposure

Effects of exposure range from acute to chronic

ECOSYSTEM

Impacts cascade through the ecosystem weakening its stability

Persistence and solubility has led to large scale contamination of areas where no pest management benefit is expected:

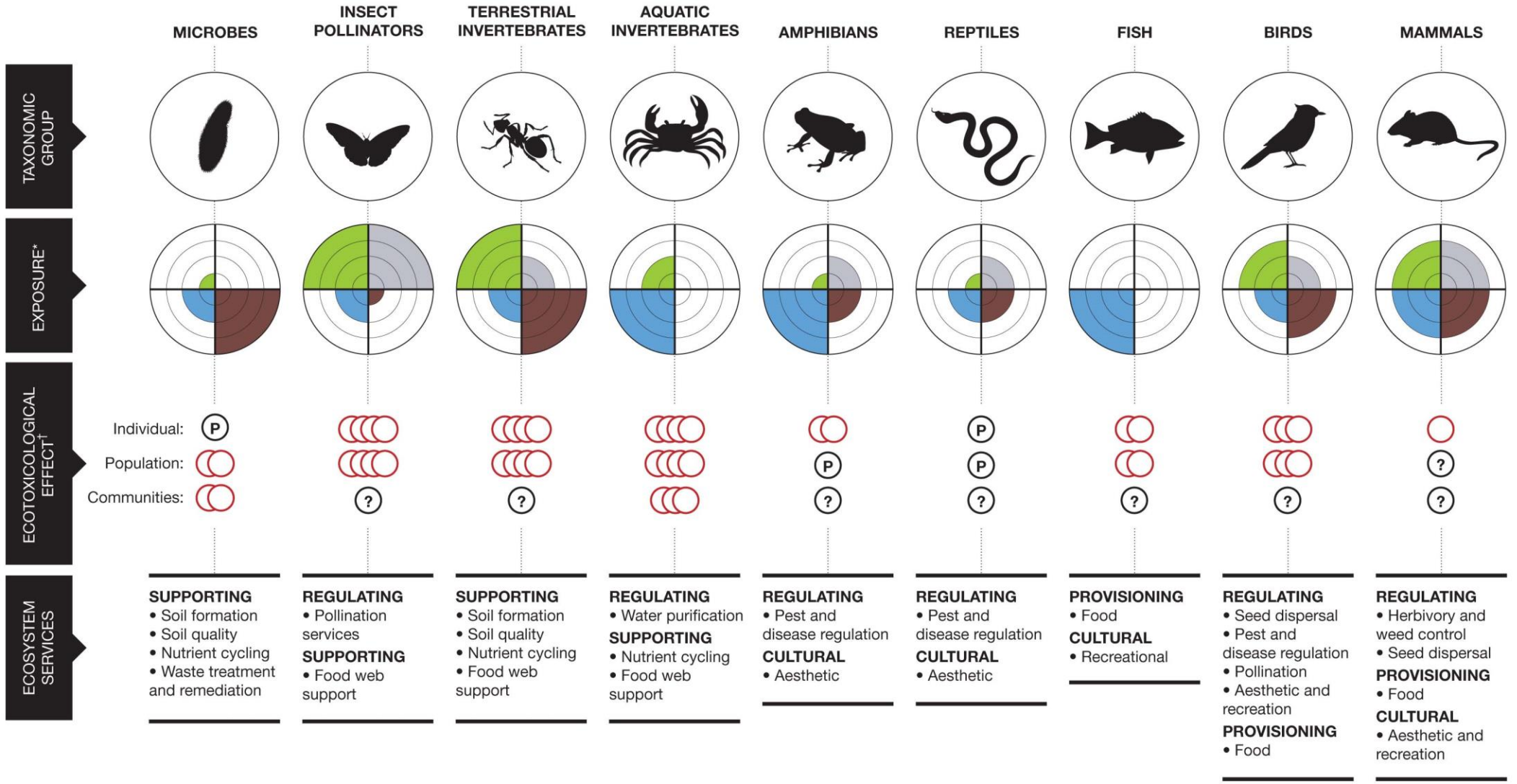
- soils and sediments
- ground and surface water
- non-treated vegetation

This provides multiple routes for exposure of non-target species

SPECIES

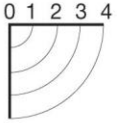
Levels resulting from authorized uses frequently exceed ‘lowest observed adverse effect concentrations’ for wide range of non-target species

Effects often sub-lethal, with exception of invertebrates



***EXPOSURE**

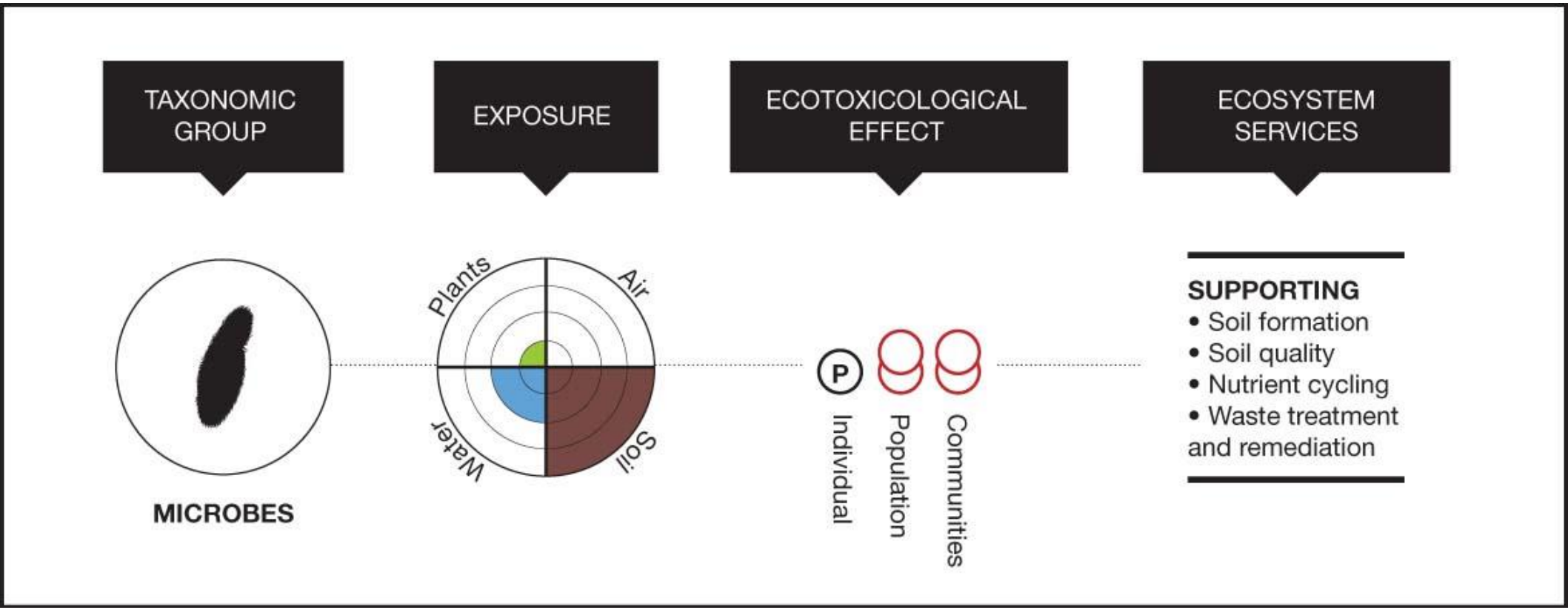
0: No route of exposure
1: Potential route of exposure assumed negligible
2: Relevant route of exposure low
3: Relevant route of exposure moderate
4: Relevant route of exposure high



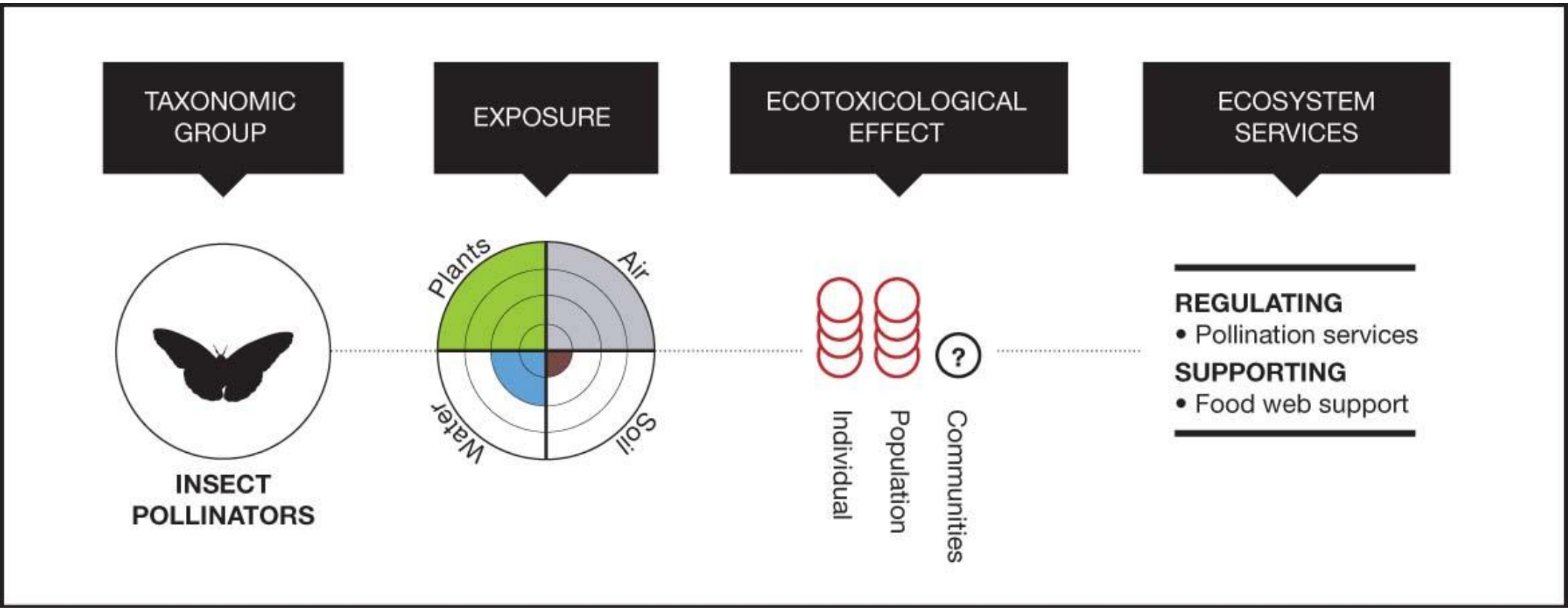
†ECOTOXICOLOGICAL EFFECT

1: Potential effects assumed negligible under normal exposure conditions
2: Evidence effects can occur but at high doses or after prolonged exposure
3: Evidence effects can occur at moderate doses
4: Evidence effects can occur at low doses or after acute exposure
?: Unknown: in situations where no judgement could be made because of lack of evidence, e.g. data unavailable
P: Probable: no accurate judgement could be made due to incomplete evidence, but data suggests a potential effect level above (1)

MICROBES


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
MICROBES
Plants
Air
Water
Soil
P
Individual
Population
Communities
SUPPORTING
• Soil formation
• Soil quality
• Nutrient cycling
• Waste treatment and remediation

INSECTS


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
INSECT POLLINATORS
Plants
Air
Water
Soil
Individual
Population
Communities
?
REGULATING
• Pollination services
SUPPORTING
• Food web support

HONEY BEES

LETHAL EFFECTS

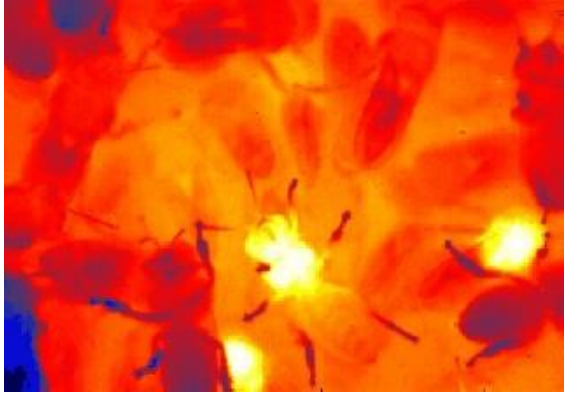
Acute toxicity (after 1 contact) – extremely high (between 7000 and 11000 higher than DDT)

Delayed toxicity – contaminated colonies do not show visible effects until some weeks or months later

Chronic toxicity at even lower doses, but during longer exposure time (e.g. 10 days)

Atypical dose-effect relationship with a high toxicity at very low and very high doses

Synergistic effects with other pesticides



HONEY BEES

SUBLETHAL EFFECTS

Behavioural modifications (learning, memory, response to stimuli, etc.)

Morphological modifications (glands or organs)

Physiological modifications (metabolic, respiratory rhythm, etc.)

Reproduction modifications (of queens and drones)

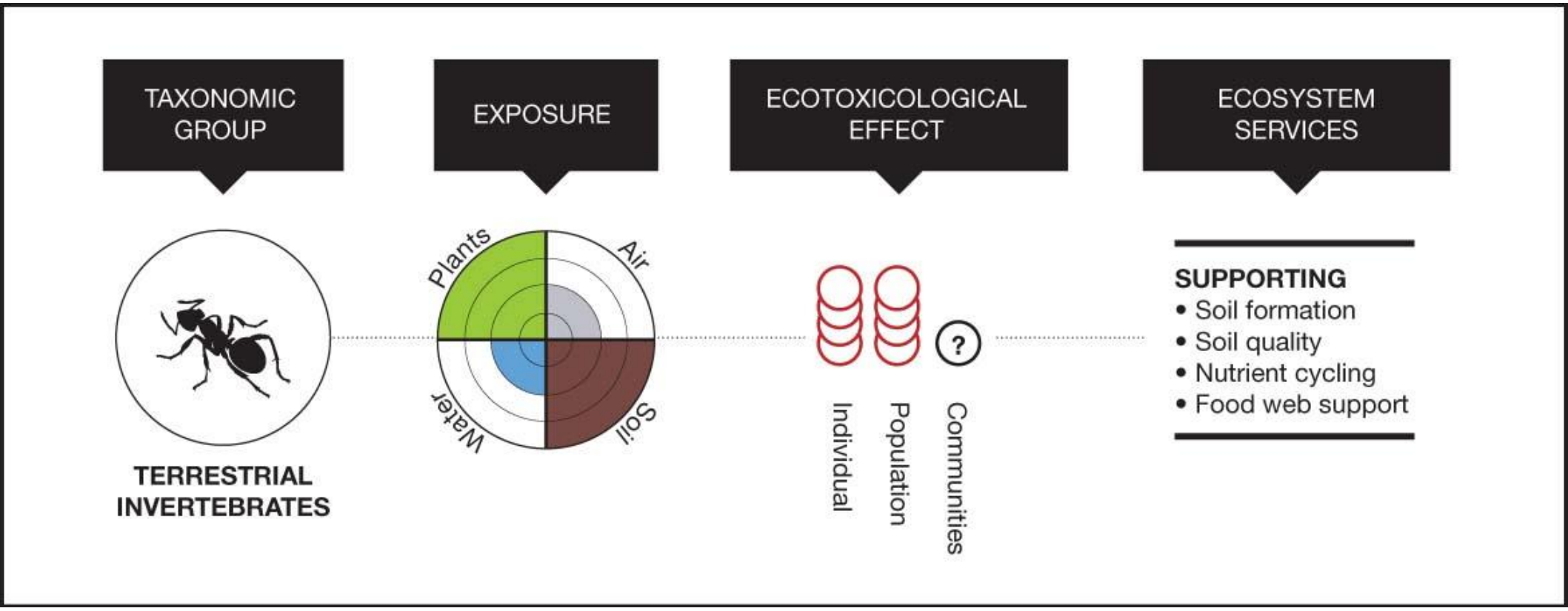
Problems with activity, locomotion, homing flight

Interactions with pathogens making bees more sensitive to develop clinical signs of disease

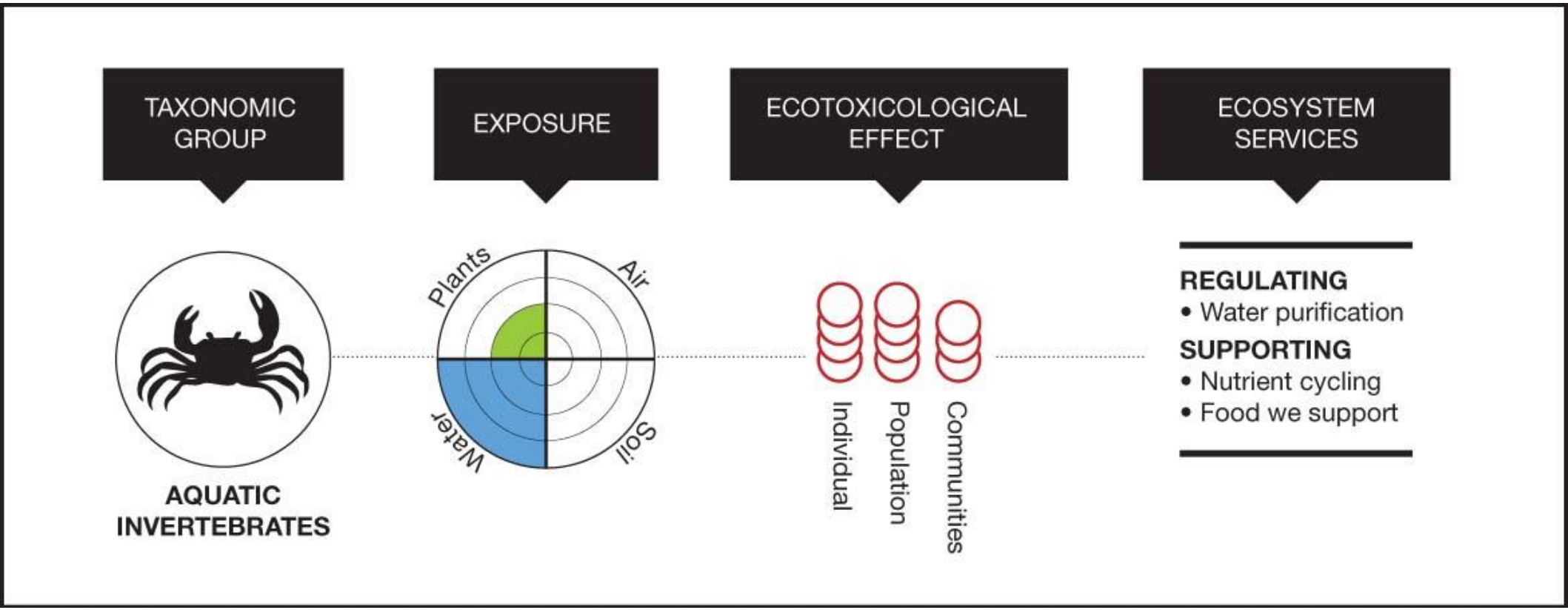
BUMBLE BEES AND SOLITARY BEES (stingless bees)

- **Different sensitivity** to neonicotinoids and fipronil depending on species - Also very toxic, but at different doses than for Apis mellifera
- Exposure is different: nesting material (soil, leaves, etc.), habitat and different **flying distances**
- **Sub-lethal effects** (incl. at field realistic concentrations)
  - Delayed hatching and detrimental effect in larvae development
  - Reduction in queen production, fecundity, and survival
  - Reduction of nest growth

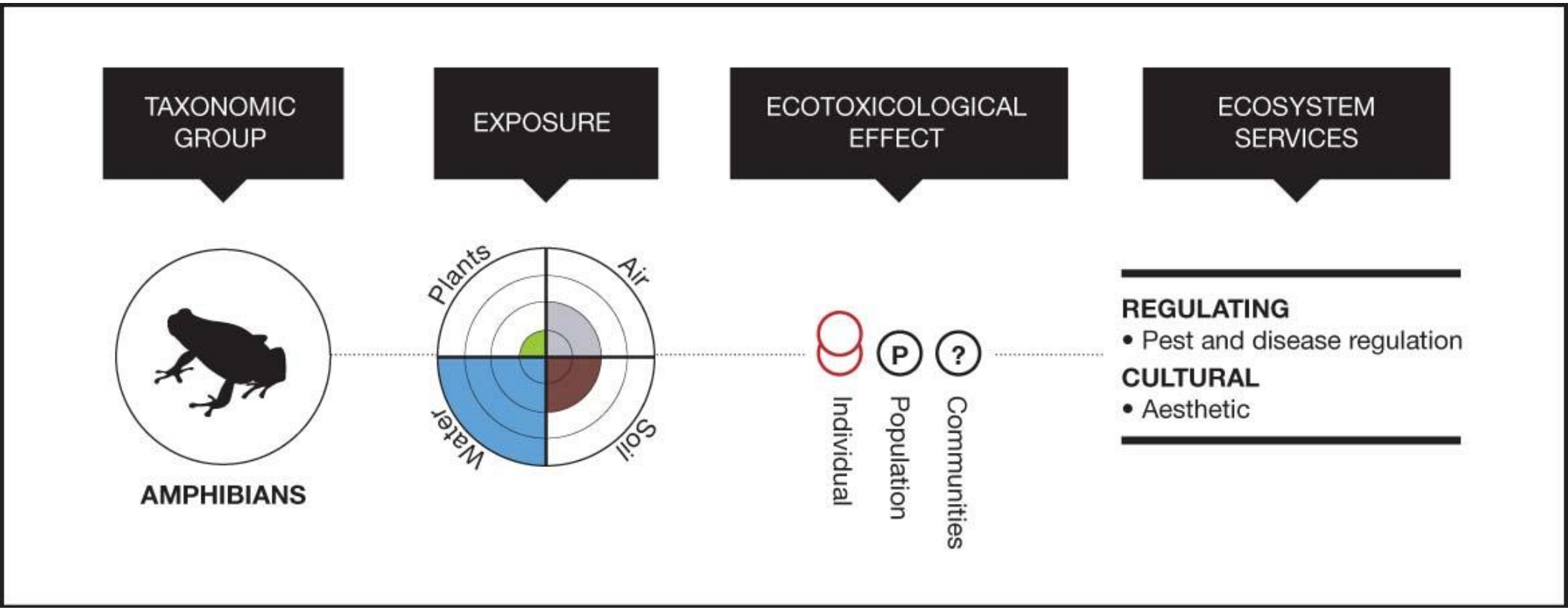
TERRESTRIAL INVERTEBRATES



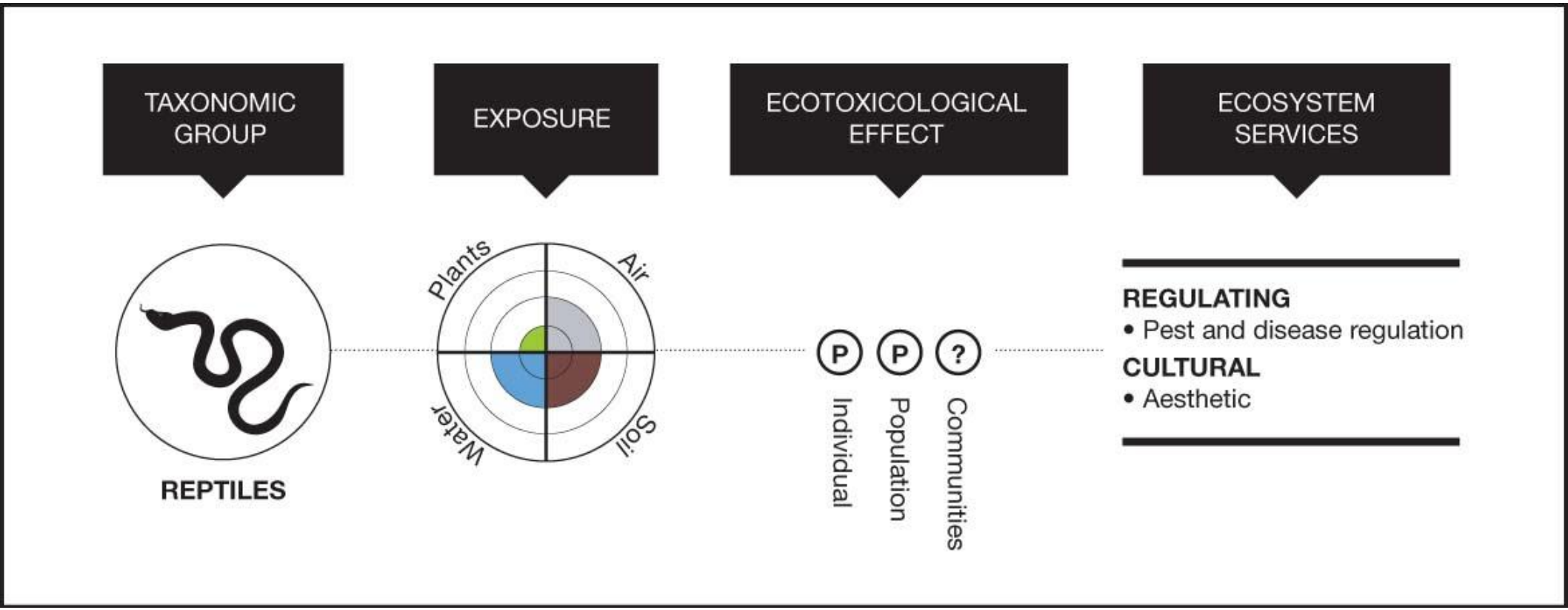
AQUATIC INVERTEBRATES



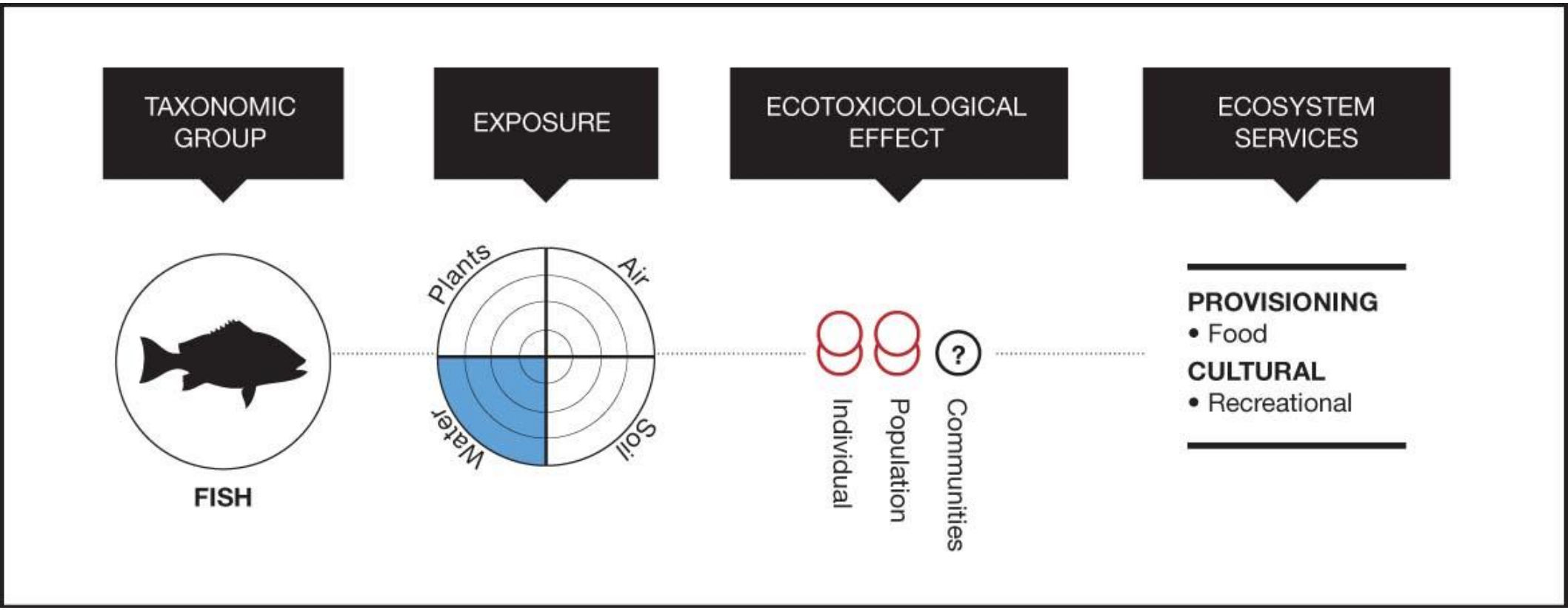
AMPHIBIANS


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
AMPHIBIANS
Plants
Air
Water
Soil
Individual
Population
Communities
P
?
REGULATING
• Pest and disease regulation
CULTURAL
• Aesthetic

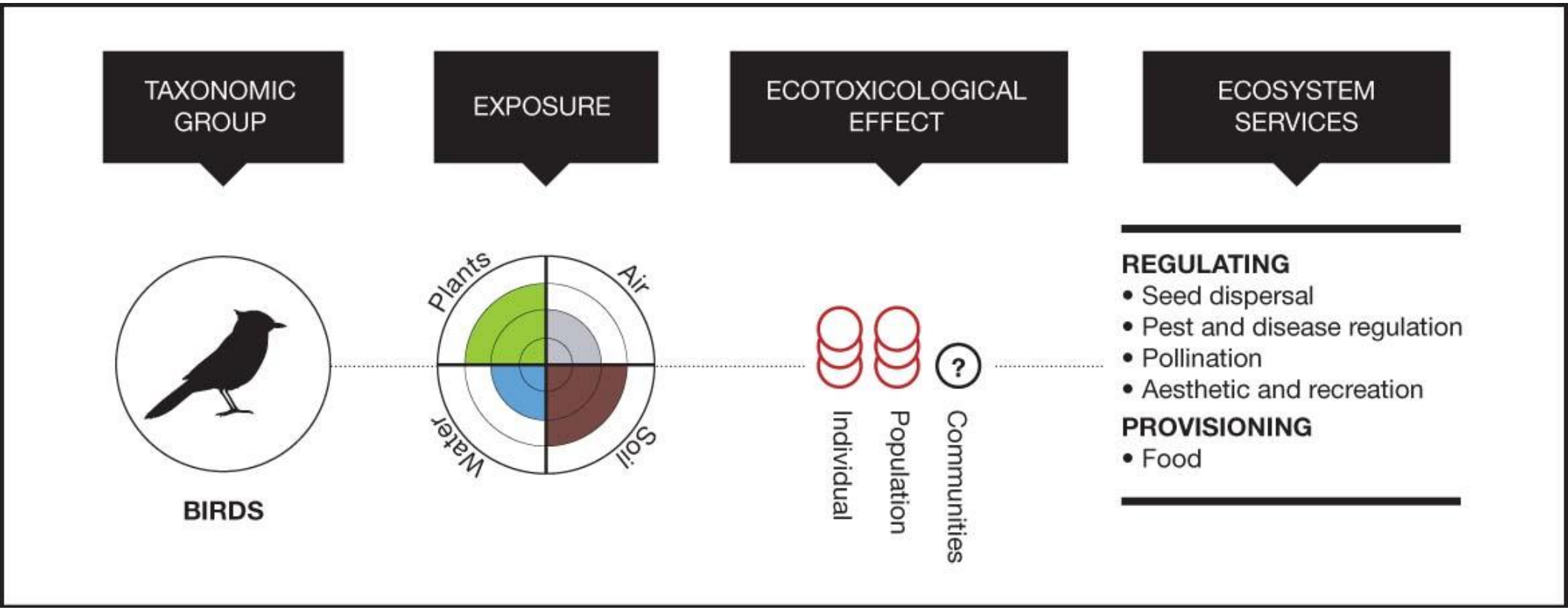
REPTILES


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
REPTILES
Plants
Air
Water
Soil
P
Individual
P
Population
?
Communities
REGULATING
• Pest and disease regulation
CULTURAL
• Aesthetic

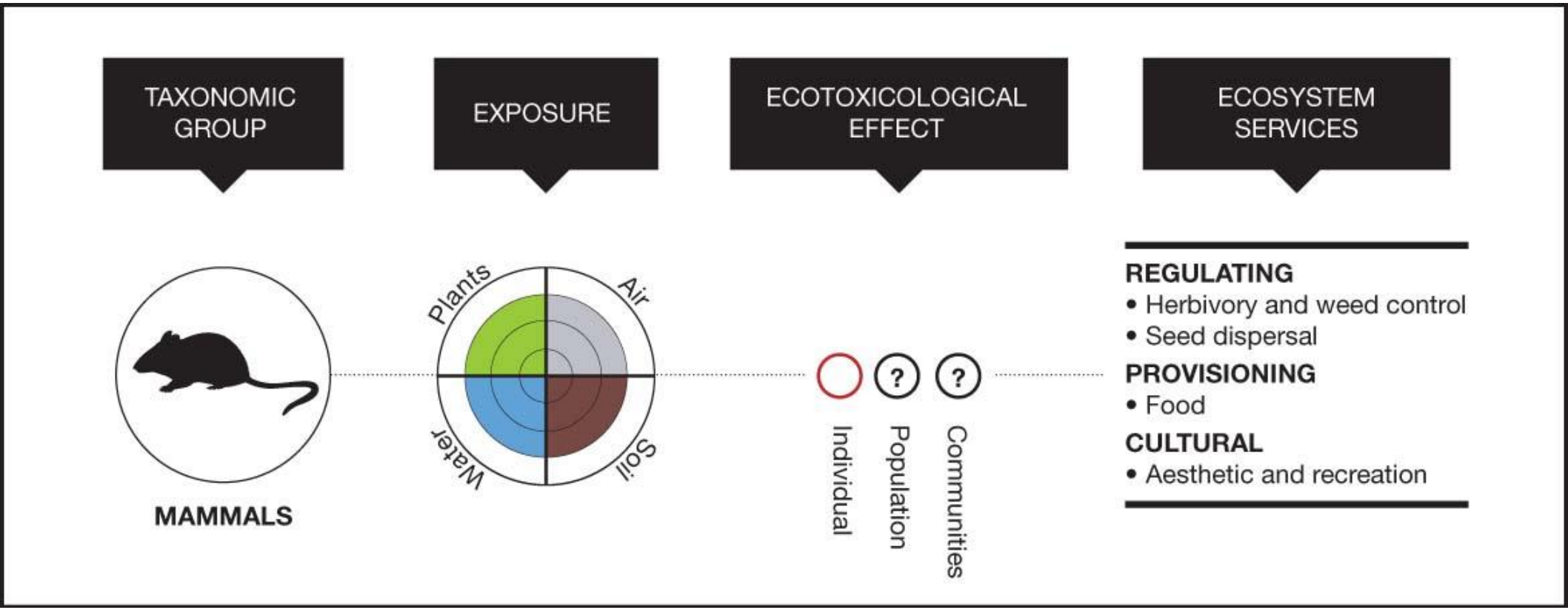
FISH


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
FISH
Plants
Air
Water
Soil
Individual
Population
Communities
?
PROVISIONING
• Food
CULTURAL
• Recreational

BIRDS


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
BIRDS
Plants
Air
Water
Soil
Individual
Population
Communities
?
REGULATING
• Seed dispersal
• Pest and disease regulation
• Pollination
• Aesthetic and recreation
PROVISIONING
• Food

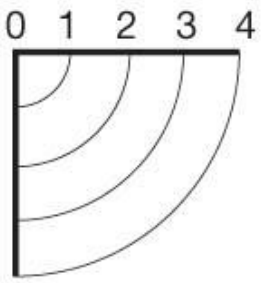
MAMMALS


TAXONOMIC GROUP
EXPOSURE
ECOTOXICOLOGICAL EFFECT
ECOSYSTEM SERVICES
MAMMALS
Plants
Air
Water
Soil
Individual
Population
Communities
?
?
REGULATING
• Herbivory and weed control
• Seed dispersal
PROVISIONING
• Food
CULTURAL
• Aesthetic and recreation

LEGEND

***EXPOSURE**

0: No route of exposure
1: Potential route of exposure assumed negligible
2: Relevant route of exposure low
3: Relevant route of exposure moderate
4: Relevant route of exposure high



†ECOTOXICOLOGICAL EFFECT

1: Potential effects assumed negligible under normal exposure conditions

2: Evidence effects can occur but at high doses or after prolonged exposure

3: Evidence effects can occur at moderate doses

4: Evidence effects can occur at low doses or after acute exposure

Unknown: in situations where no judgement could be made because of lack of evidence, e.g. data unavailable

Probable: no accurate judgement could be made due to incomplete evidence, but data suggests a potential effect level above (1)

GAPS

Exposure

- Little data about quantities applied or treated area location, nor much screening of concentrations in the environment
- Lacking data on environmental fate of metabolites
- Poor knowledge of dynamics of degradation and fate once in the environment

Toxicity

- Toxicity to most organisms not investigated, and when it is, it does not consider long-term toxicity
- Little known about toxicity to soil organisms (beyond earthworms), marine systems or vertebrates (eg. birds that may eat treated seeds)
- Sub-lethal effects not studied in most organisms
- Unknown effects of co-exposure to different a.s. With same nAChRs
- Cumulative toxicity of successive and simultaneous exposure not studied
- Interactions between neonicotinoids and fipronil and other stressors (pesticides, disease, food stress, etc) only studied in limited species

CONCLUSIONS

Present scale of use not sustainable and alternatives exist and are economically viable

Continued use can only:

- accelerate global decline of important invertebrates
- risk reduction in levels of diversity security
- risk reduction in stability of ecosystem services

Large scale, prophylactic use must be reconsidered

THE REGULATORY CONTEXT

Authorization before Directive 91/414 – National

1st Authorization under 91/414 – Risk Assessment very deficient

Re-Authorization under 1107/2009 – BUT, 2012 scientific studies + update of Risk Assessment methodology changed everything

2013 – Partial suspensions
2018 – Further suspensions

Thank you for your attention and to:

Main founder of the study:

Triodos Foundation

Co-founders or supporters: Adessium Foundation (The Netherlands), Act Beyond Trust (Japan), Universiteit Utrecht (Netherlands), Gesellschaft fuer Schmetterlingsschutz (Germany), M.A.O.C. Gravin van Bylandt Stichting (The Netherlands), Zukunft Stiftung Landwirtschaft (Germany), Study Association Storm (Student Association Environmental Sciences Utrecht University), Bee Life European Beekeeping Coordination