MULTIPLE CONTAMINANTS IN COMPLEX COMMUNITIES

EVALUATING NON-ADDITIVE EFFECTS OF MULTIPLE SIMULTANEOUS STRESSORS ON BIOMASS FLUX AND ECOSYSTEM FUNCTIONING

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INTRODUCTION

THE CHALLENGE

Current approaches to **environmental risk assessment** (ERA) are often limited to assessing the effect of single contaminants on single species, overlooking the effects that can occur at higher ecological scales.

Can we develop tools for ERA that allow us to evaluate how **multiple contaminants** acting on **multiple traits** among species in communities impact **biodiversity, stability and ecosystem function**?

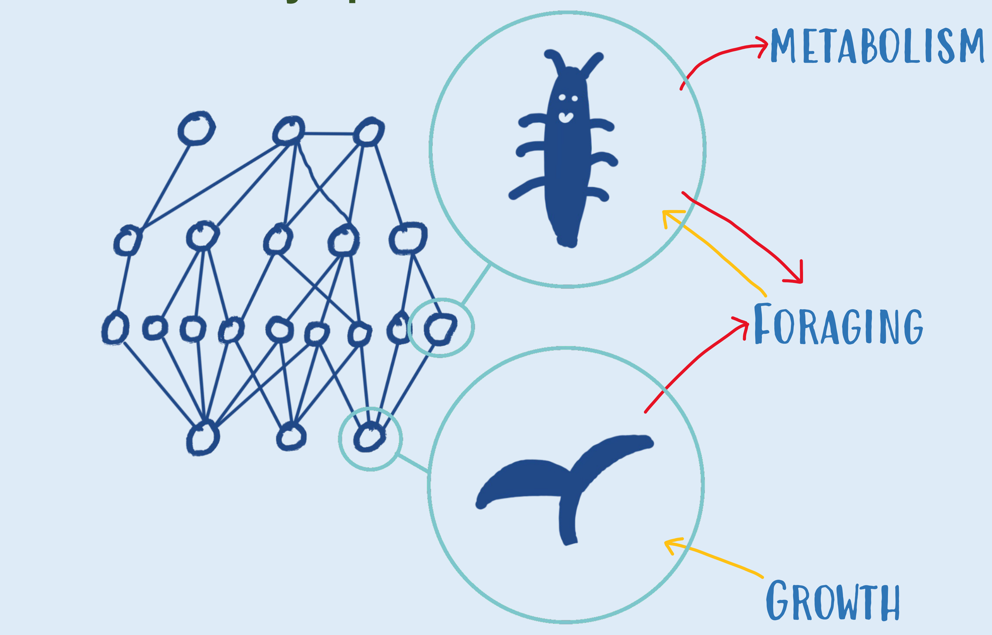
METHODS

IN SILICO EXPERIMENTAL DESIGN

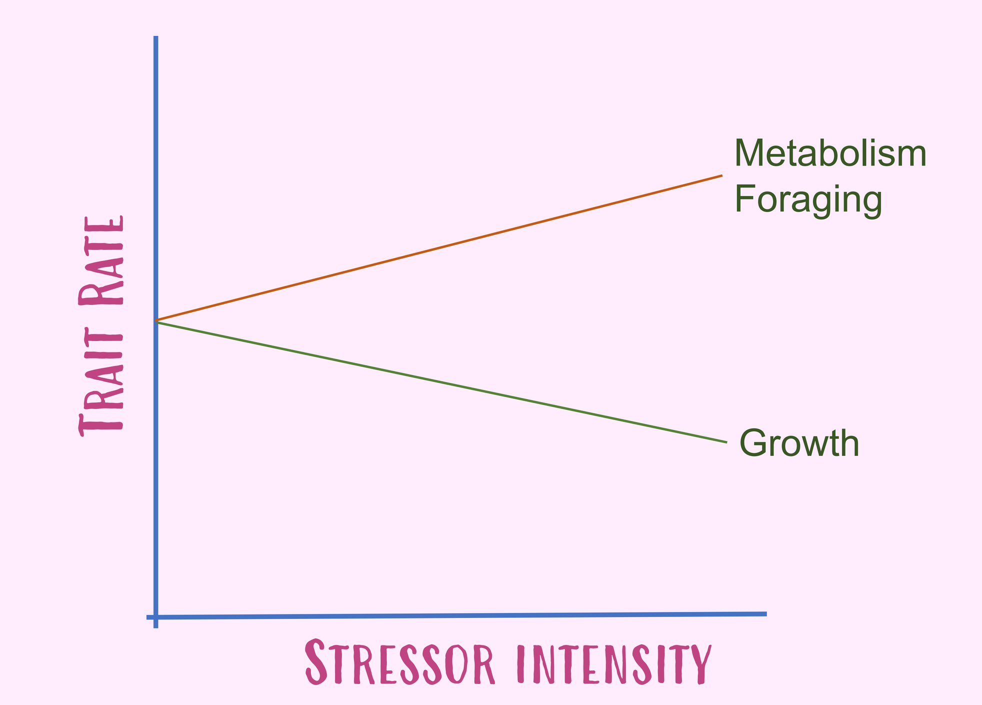
- Use differential equation **food web model** to simulate dynamics of plausible **tri-trophic** food chain
- Specify inhibitory **contaminant effects** on populations via linear reductions or increases of trait rates
- Generate 2-contaminant scenarios with
  - **1 herbicide targeting growth** and
  - **1 pesticide targeting either metabolism or foraging**
- Measure **community biomass**
- **Classify interactions** by calculating deviation from additivity of community biomass[3]

FOOD WEB MODELLING

Biomass dynamics in a community are determined by species traits [1]



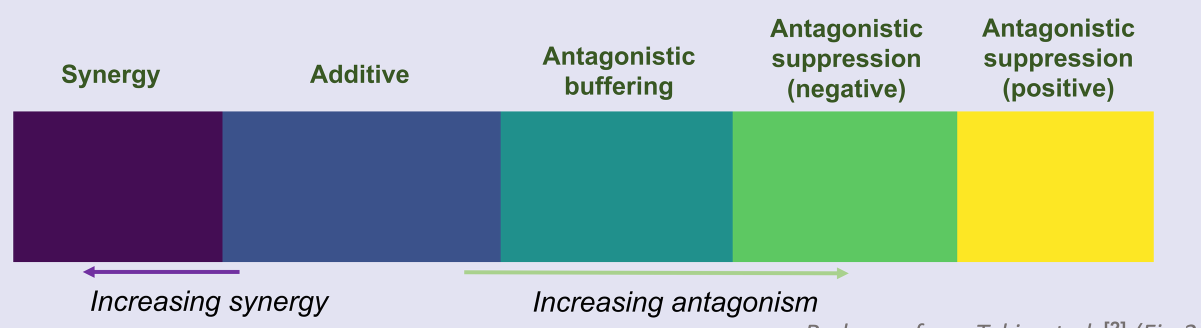
CONTAMINANT EFFECTS



CLASSIFYING INTERACTIONS

Using Tekin *et al.*'s framework for measuring **ecological stressor interactions** [2] , which incorporates;

- **Standardisation** of effect sizes (rescaling)
- **Categorisation** of interaction types
- Measures **Deviation from Additivity** (DA)
  - Synergy, Buffering and Suppression

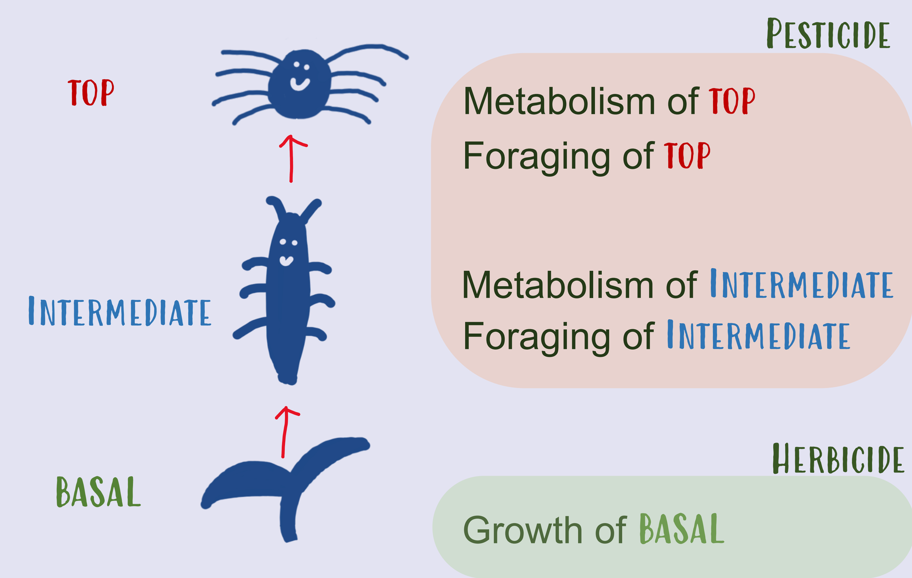


Redrawn from Tekin et al. [2] (Fig 2)

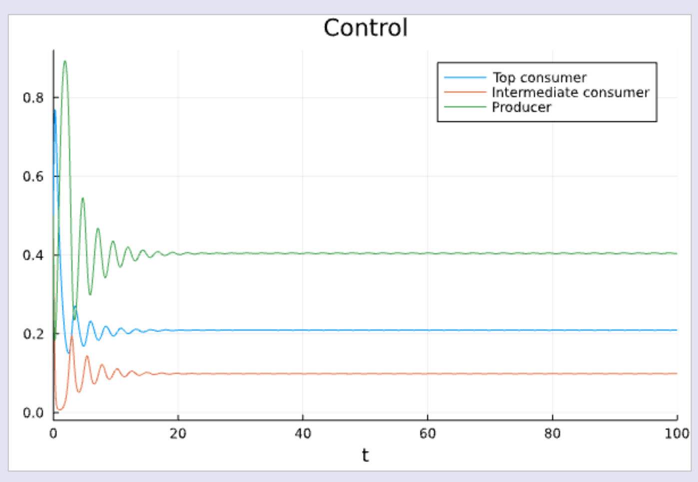
- Synergy – joint effect greater than sum of its parts
- Additive – no interaction
- Antagonistic buffering – joint effect smaller than sum of its parts
- Antagonistic suppression (negative) – effect of negative stressor masks that of the positive stressor
- Antagonistic suppression (positive) – effect of positive stressor masks that of the negative stressor

3 SPECIES CASE STUDY

VARYING TARGET TRAIT



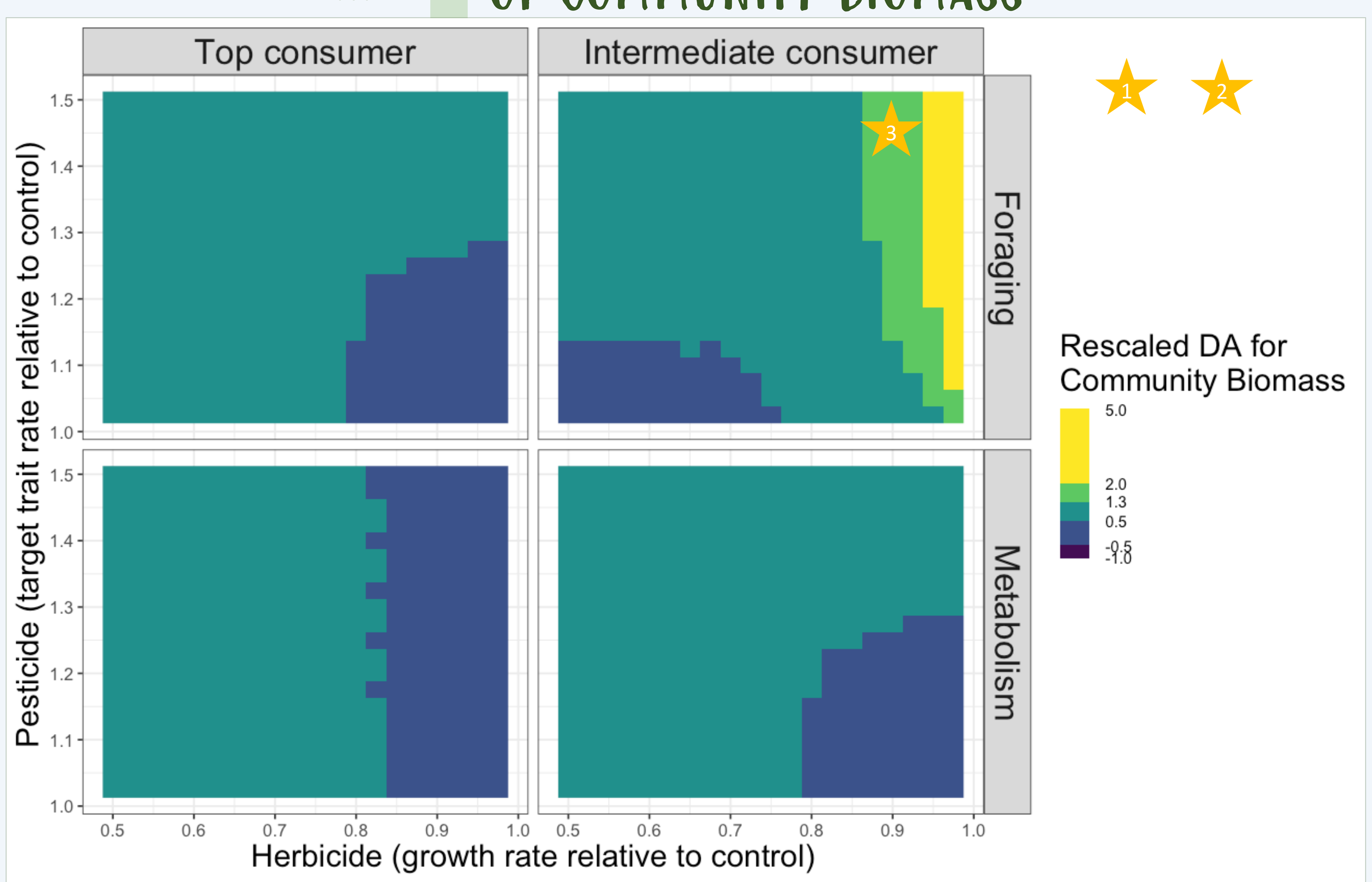
MEASURING BIOMASS



RESULTS

VARIATION IN...

RESCALED DEVIATION FROM ADDITIVITY OF COMMUNITY BIOMASS



CONCLUSIONS

1. **Community biomass** is differentially impacted depending on the **trait and trophic level** targeted by the pesticide
2. **Additivity, antagonistic buffering and antagonistic suppression** are the most commonly observed interaction types, with **no synergy** observed
3. **Antagonistic suppression** is observed when pesticides target **foraging** in the **intermediate consumer**, due to compensatory biomass dynamics inherent to the model resulting in reallocation of biomass among trophic levels

FUTURE WORK

1. Explore buffering and suppression of total biomass by exploring biomass re-allocation across trophic levels
2. Apply method to stability
3. Expand community complexity

TOWARDS REDEFINING ERA

How do multiple contaminants impact biodiversity, stability and ecosystem function through…

Target trait (*mode of action*)
Target species (*contaminant specificity*)
Target trophic level
Community size, structure and complexity
Environmental conditions

REFERENCES

[1] Williams, Brose & Martinez (2007) Homage to Yodzis and Innes 1992: Scaling up feeding-based population dynamics to complex ecological networks

[2] Tekin *et al.* (2020) Using a newly introduced framework to measure ecological stressor interactions