Developing Research Proposals 28/11/2025

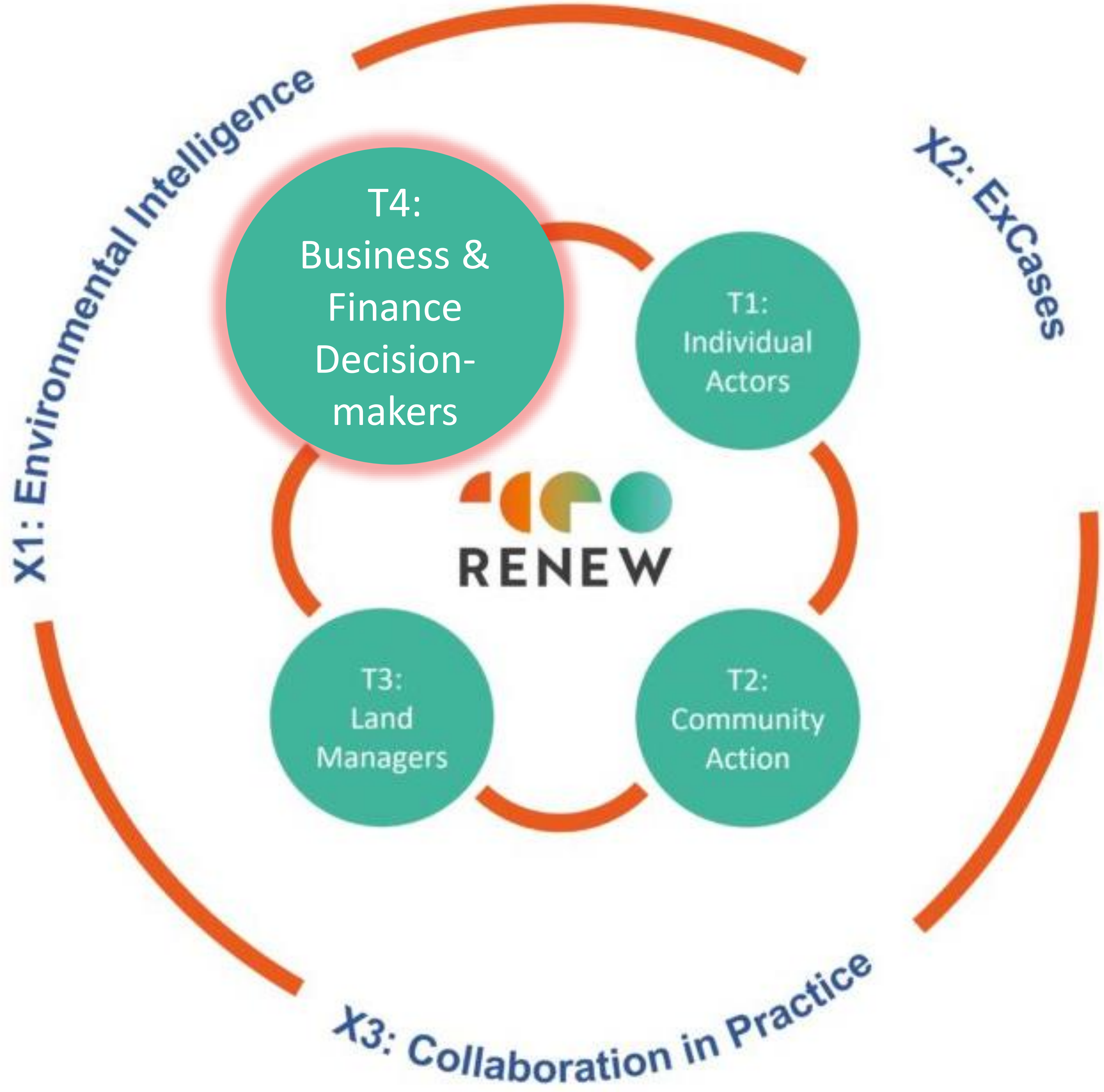
13:00-13:15	Participant introductions
13:15-13:40	Project 1: AI for management approaches in sustainable farming (Markus Mueller)
13:40-14:05	Project 2: The National Trust food and beverage footprint: AI for sustainability analytics (Maria Eugenia Correa Cano)
14:05-14:15	Break
14:15-14:40	Project 3: Use of machine learning to enable an aquaculture enhanced future for the UK (Robert Ellis)
14:40-15:10	“Elevator pitches” of other projects from workshop participants
15:10-15:30	Wrap up and next steps

RENEW

The National Trust food & beverage footprint: AI for sustainability analytics

Maria E. Correa Cano

28/Nov/2025



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- **RENEW is a five-year partnership programme in the UK to develop solutions to one of the major environmental challenges for humankind:**

The renewal of biodiversity

Theme 4:
Business & Finance Decision-makers

https://renewbiodiversity.org.uk/about/

In Theme 4-Renew, we want to help organisations to (better) understand their biodiversity impacts and drive change in decision making that can have positive effects on biodiversity

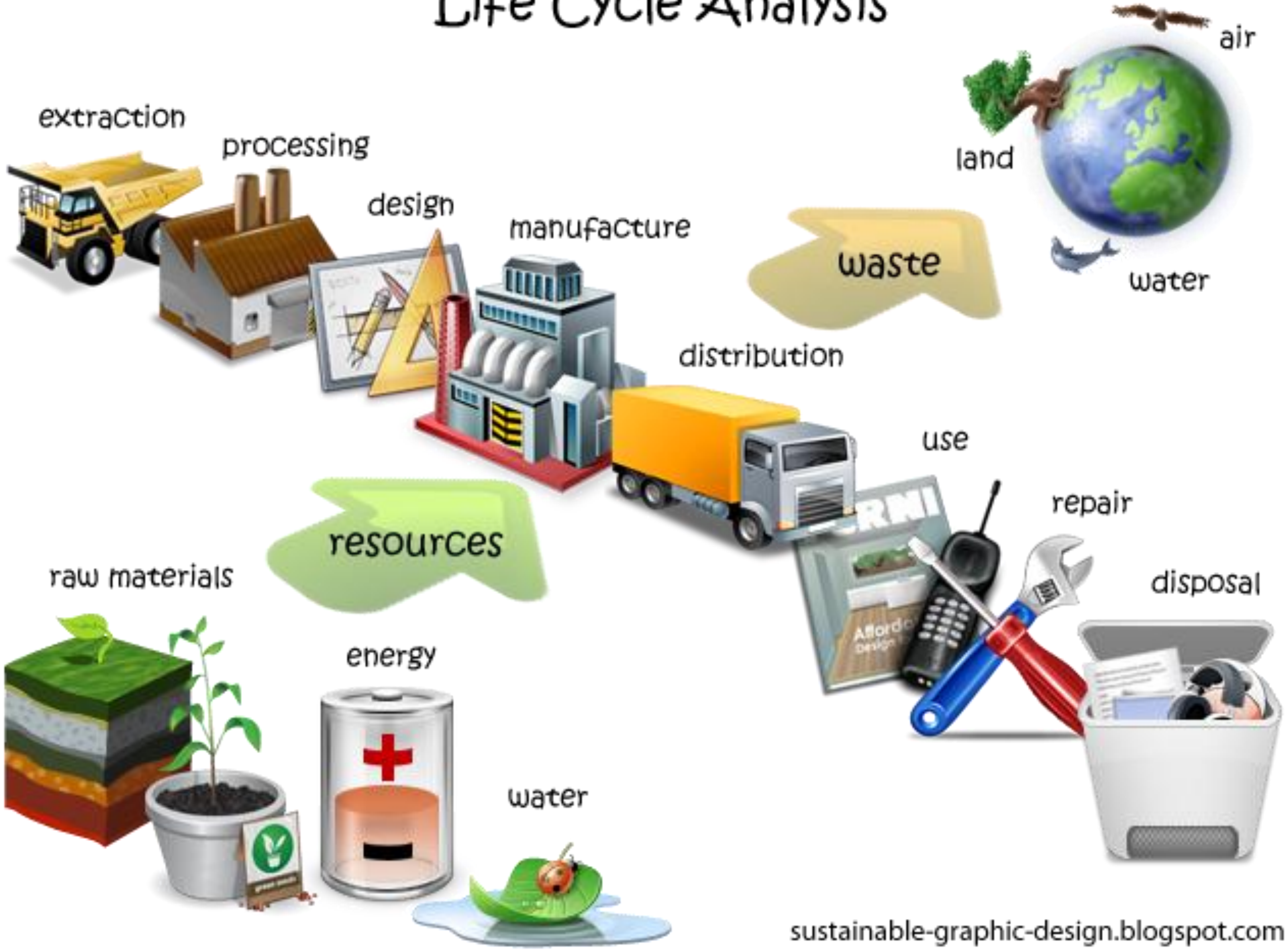
How?

Following a life cycle assessment (LCA) based approach to assessing an organisation's biodiversity impacts.

Tested on three case studies to demonstrate broad applicability:

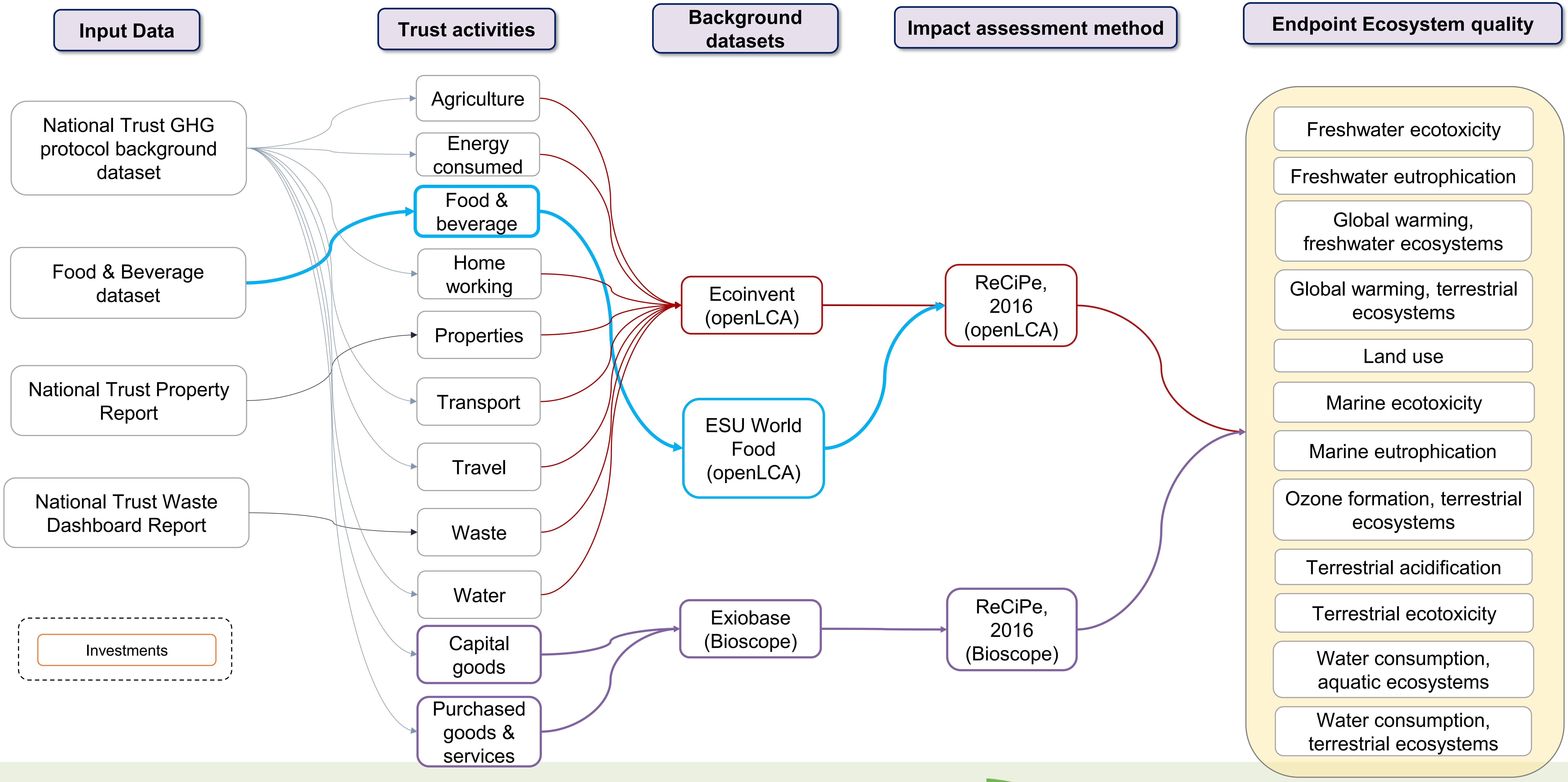
1. **The National Trust**
2. **The NatWest Group**
3. **The University of Exeter**

Life Cycle Analysis



sustainable-graphic-design.blogspot.com

Summary of the National Trust assessment



RESULTS

Overall impacts

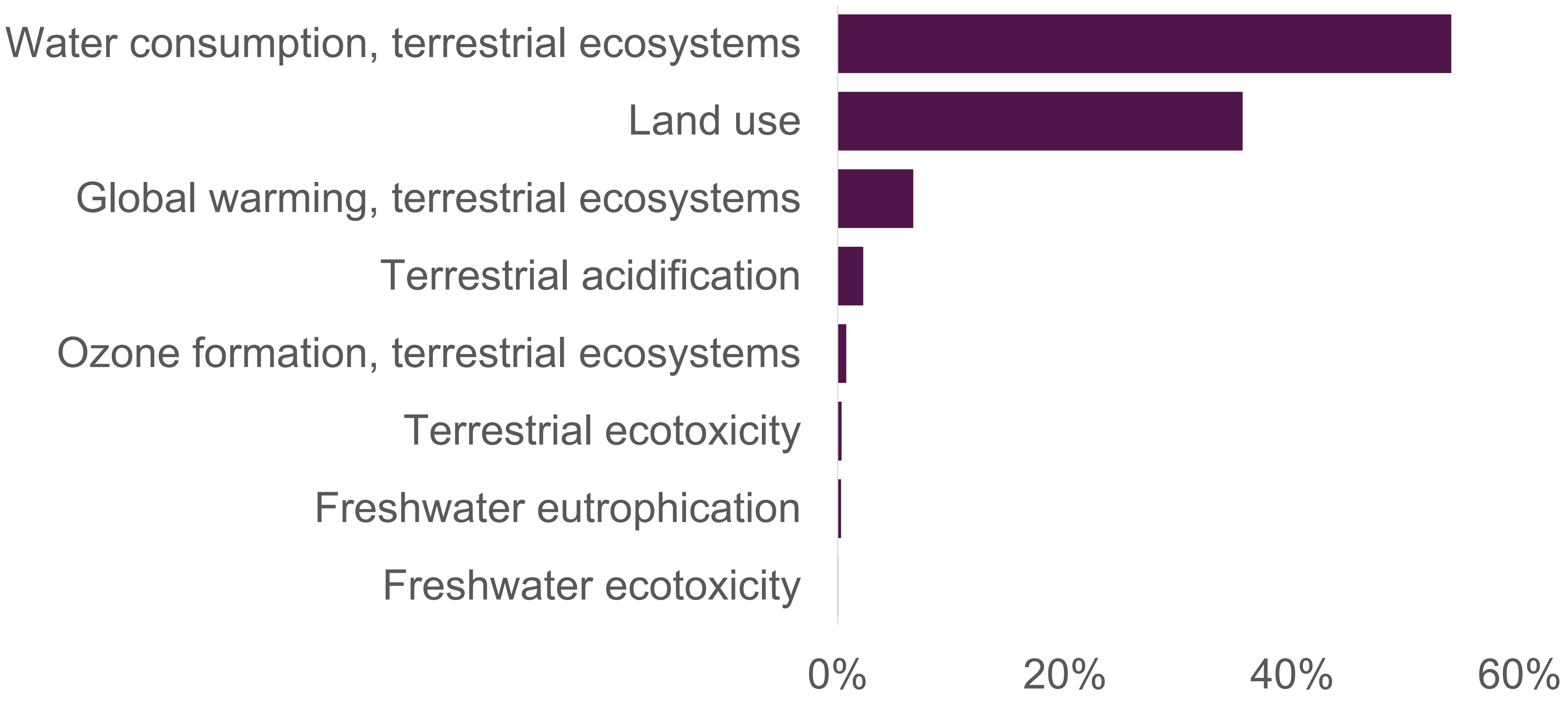
Colour key: -3.4E-5 to 5.2

Category	Trust activities	Total PDF	%
Agriculture	In-hand management	0.03	0.4%
	Tenant farms	6.71	84.6%
Energy	Coal	0.00	0.0%
	Electricity (market-based)	0.01	0.1%
	LPG	0.00	0.0%
	Natural gas	0.00	0.0%
	Oil	0.00	0.0%
Food & beverage	Food & beverage	0.72	9.1%
Home working	Home working	0.04	0.5%
Properties	Tenant buildings- Residential	0.08	1.0%
	Tenant buildings- Non-Residential	0.02	0.3%
Transport	Downstream transport	0.10	1.2%
	Fleet vehicles & machinery	0.00	0.0%
Travel	Business travel - Flights	0.00	0.0%
	Business travel - Land transport	0.00	0.0%
	Business travel - Hotels	0.00	0.0%
	Employee commutting	0.19	2.3%
Waste	Anaerobic digestion	0.00	0.0%
	Landfill	0.00	0.0%
	Incineration	0.00	0.1%
	Recycled	0.00	0.0%
Water	Water	0.03	0.3%

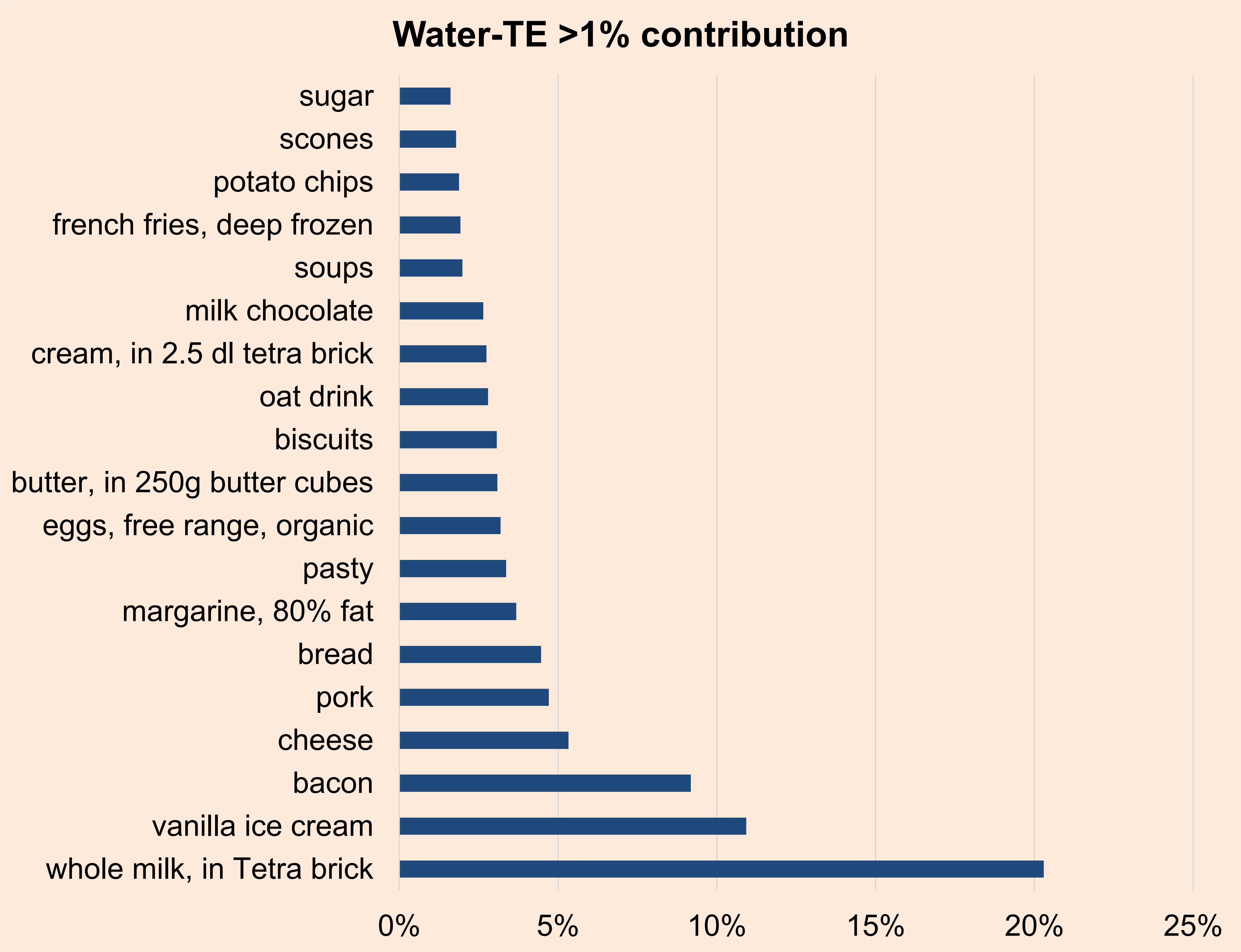
Stop at The Pantry for a refreshing coffee and a slice of cake | © National Trust Images/Arnhel de Serra

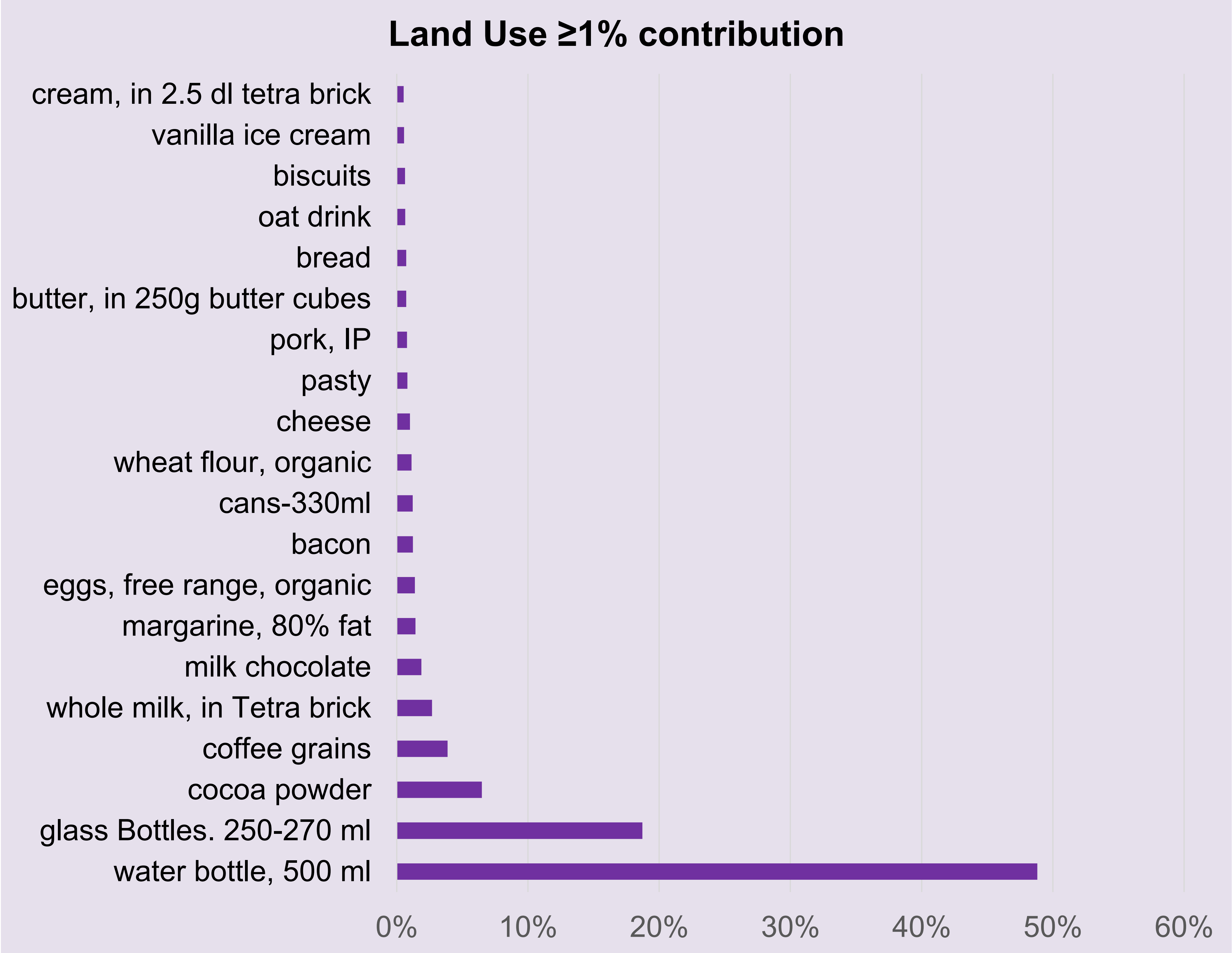
Correa-Cano, et. al. J. Env. Manag. *Under revision*

Biodiversity footprint of Food & Beverage

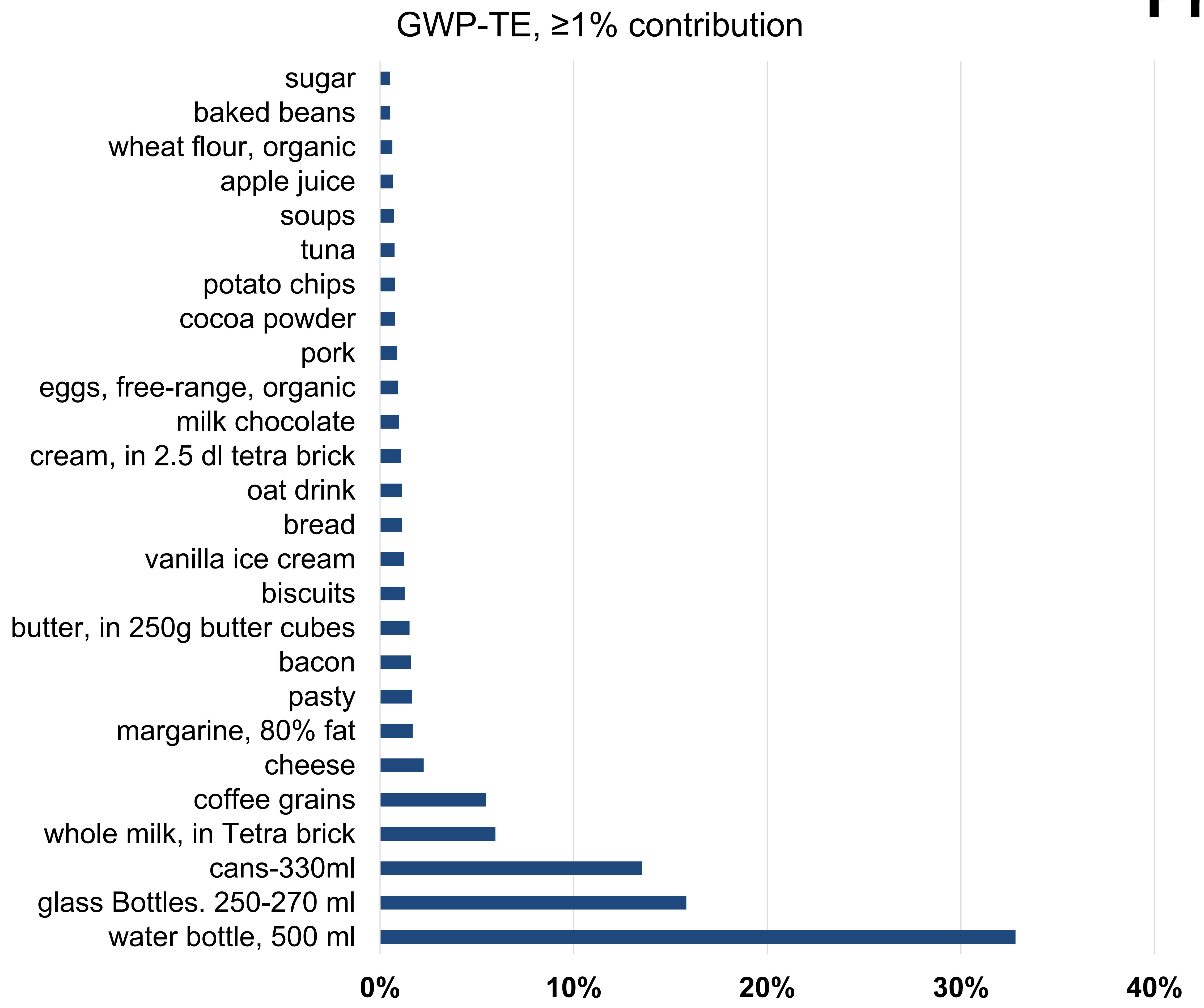


Product-specific contribution





Product-specific contribution



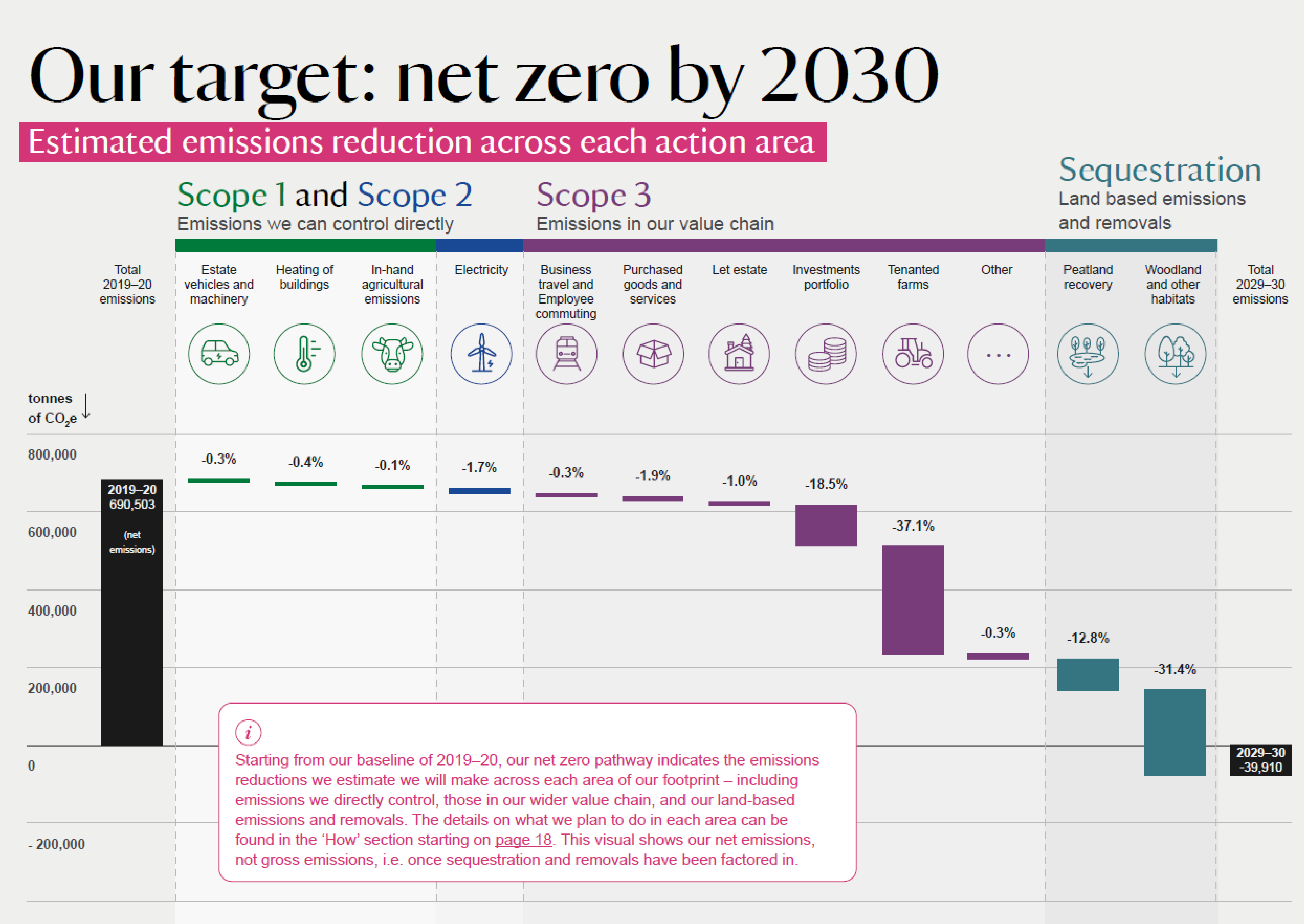
RENEW

University of Exeter

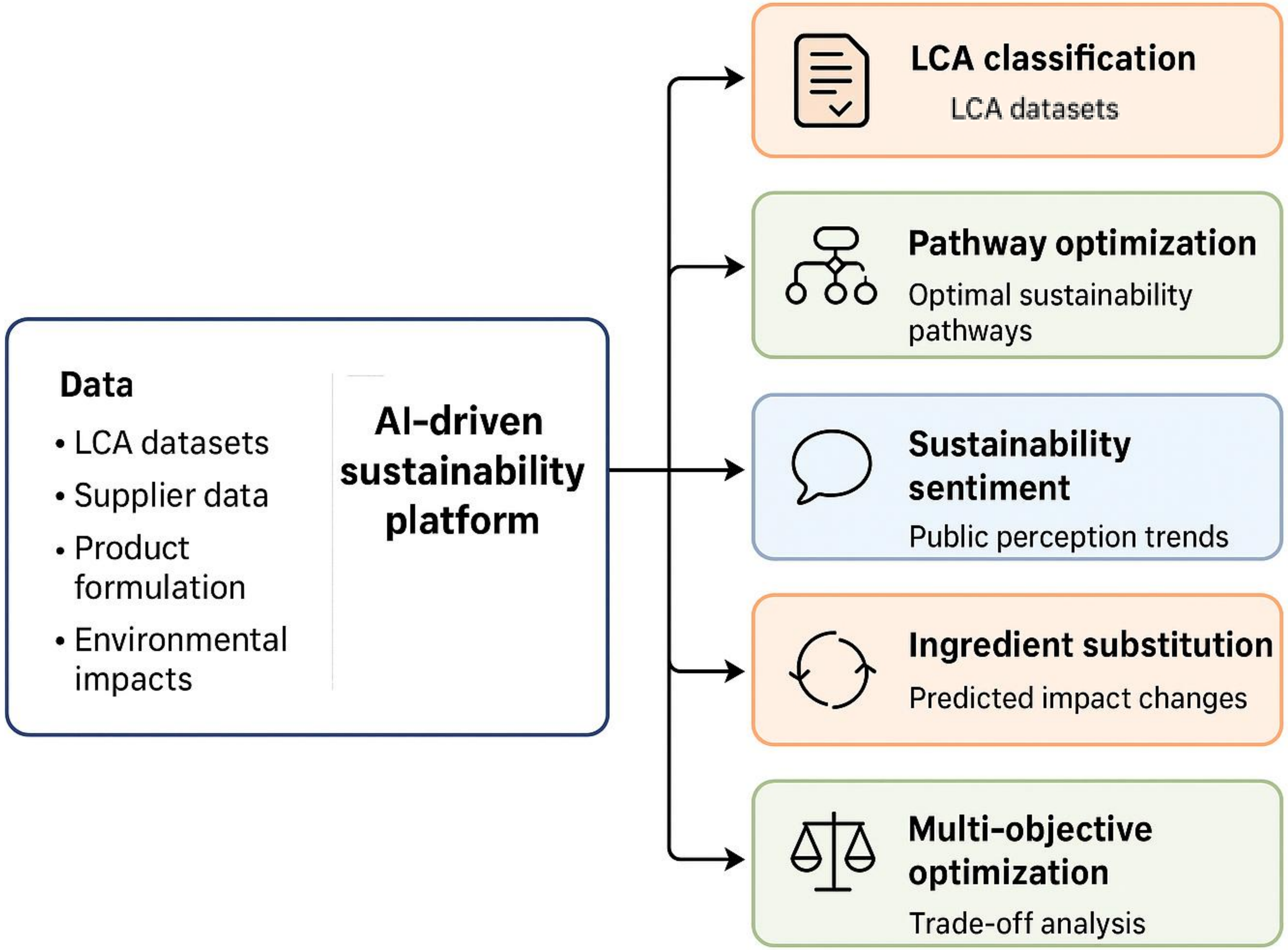
National Trust

UKRI Natural Environment Research Council

Opportunities to develop further analysis



Potential of using AI for sustainability analytics



Comment /other topics	Interest in participating?

RENEW
University of Exeter
National Trust
Natural Environment Research Council

Thank you

University of Exeter

- Xiaoyu Yan
- Maria E. Correa-Cano

The National Trust

- Rosie Hails
- Lizzy Carlyle
- Emma Zimmerman
- Matthew Heard

RENEW

A people-in-nature approach

RENEW Biodiversity
Environment and Sustainability Institute
University of Exeter, Penryn Campus
Penryn, Cornwall, TR10 9FE

@RENEW_nature
#renewbiodiversity

www.renewbiodiversity.org.uk

University of Exeter

Creating the right environment for an aquaculture enhanced future

Dr Robert Ellis

Senior Lecturer in Ecophysiology and Sustainable Aquaculture

Co-Director of Global Engagement - Biosciences

R.P.Ellis@exeter.ac.uk

The challenge – global

Feeding 10 billion of us

Half current food production relies on **exceeding planetary boundaries**

1/3 of food produced (931 MT) is **never eaten!**

Climate change projected to **reduce food production by up to 40 %** this century*

Current system can provide **balanced diet** for **ONLY 3.4 billion people** within **planetary boundaries**

BUT - Transformation towards **sustainable production & consumption** increases this to **10.2 billion** people

nature food

Article

https://doi.org/10.1038/s43016-025-01252-6

Identifying the safe operating space for food systems

Received: 9 February 2025

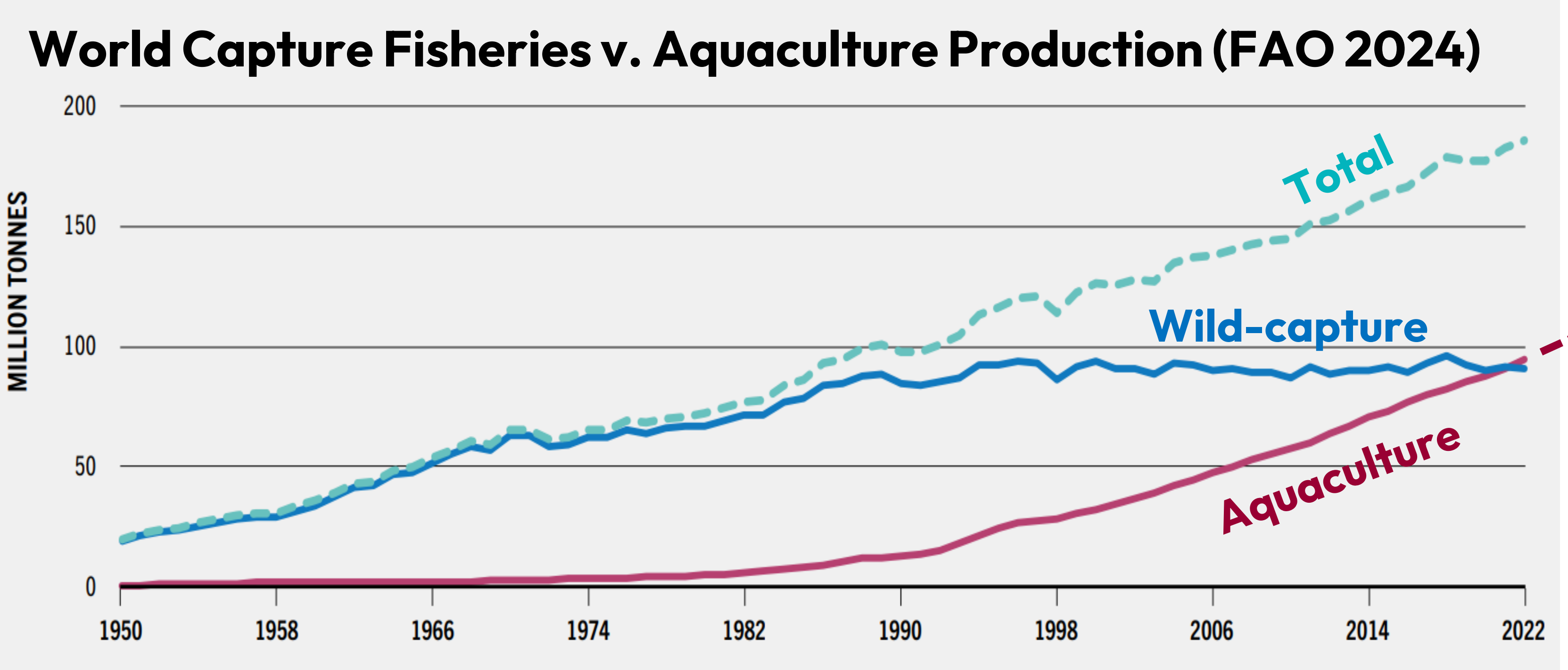
Accepted: 30 September 2025

Published online: 31 October 2025

Sofie te Wierik[1,2], Fabrice DeClerck[3,4], Arthur Beusen[2,5], Dieter Gerten[1,6], Federico Maggi[7], Anna Norberg[1], Kevin Noone[8], Lena Schulte-Uebbing[2], Marco Springmann[9], Fiona H. M. Tang[10], Wim de Vries[11], Detlef van Vuuren[2,12], Sonja Vermeulen[13] & Johan Rockström[1,14,15]

Planetary boundaries: 9 critical Earth-system processes that define a "safe operating space" for humanity

Global seafood production



Aquaculture production must <u>double</u> by 2050

Global seafood production – 222 Mt in 2022 ($472 billion)

Aquaculture provides 59 % of seafood for human consumption

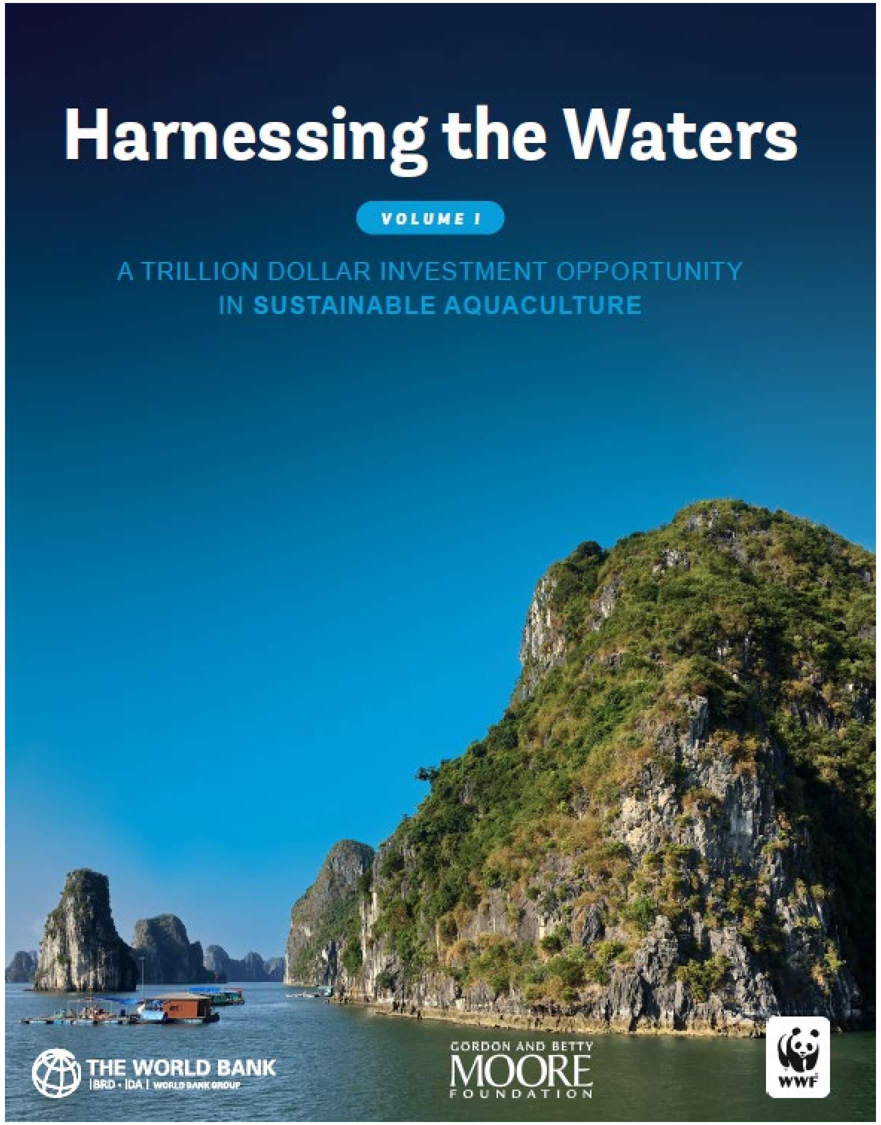
FAO. 2024. The State of World Fisheries and Aquaculture 2024. Blue Transformation in action. Rome. https://doi.org/10.4060/cd0683en

The opportunity – global

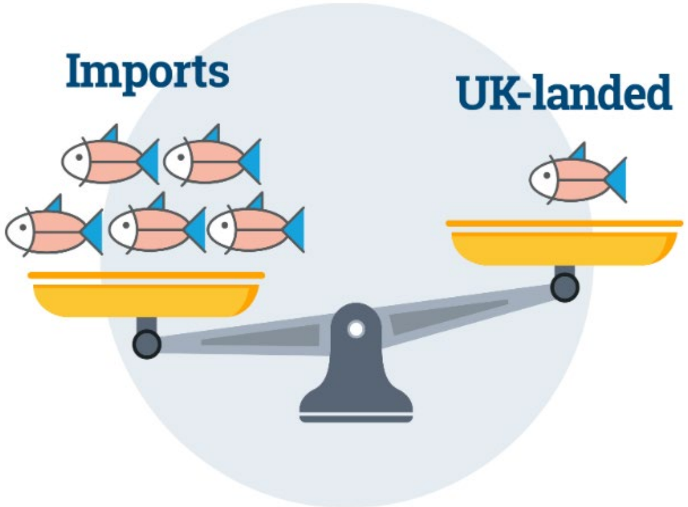
Blue transformation of aquatic food systems critical for a sustainable global food future

Could generate 22 million new jobs by 2050

$1.5 trillion dollar global investment opportunity



The challenge – UK



UK is net importer of seafood
(2024 imported 1.16 million tonnes = £3.84 billion)

Export most seafood landed or farmed in UK **(£1.9 billion)**

seafish

UK population growth (12 million by 2050), requires **~1,230 more tonnes protein per day** (SAGB)

No seafood representatives on Food Strategy Advisory Board

Department for Environment, Food & Rural Affairs

Policy paper
A UK government food strategy for England, considering the wider UK food system
Published 15 July 2025

'*We have* ***deliberately narrowed our focus onto the land***' (The National Food Strategy, 2021)

Shellfish Association of Great Britain

The opportunity – UK

SEAFOOD 2040

A strategic, collaborative seafood initiative for England

Government target of increasing **seafood consumption by 75 % by 2040** population

Target a **10-fold increase in aquaculture** production by 2040

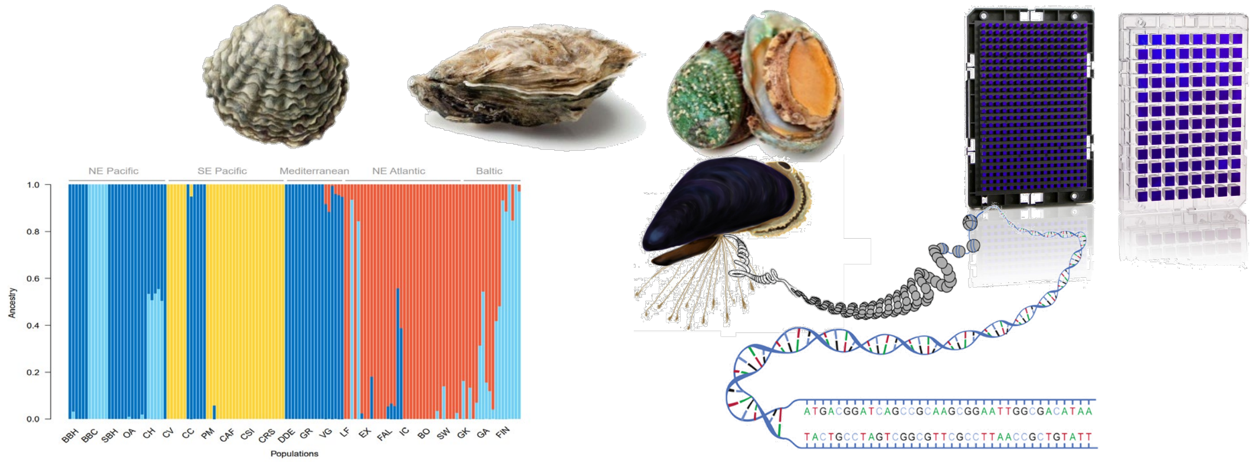
Defra announced 12-year £**360M Fishing and Coastal Growth Fund** - May 2025

Optimising aquaculture ecosystems

- Full parameterisation of diverse production environments
- Comparative analysis of species physiology / biology
- Development of novel production systems (e.g. Recirculating Aquaculture Systems, RAS)
- Optimisation of aquaculture management practices/protocols

Optimising aquaculture species

- Optimise species to suit environment
- Develop novel genomic tools for aquaculture species
- Generate data to understand optimal environment for species
- Facilitate informed planning – siting aquaculture farms where we predict they will thrive in 20 years….



Proposed project 1 – mussel restoration, bioremediation, biomonitoring and biorefinery

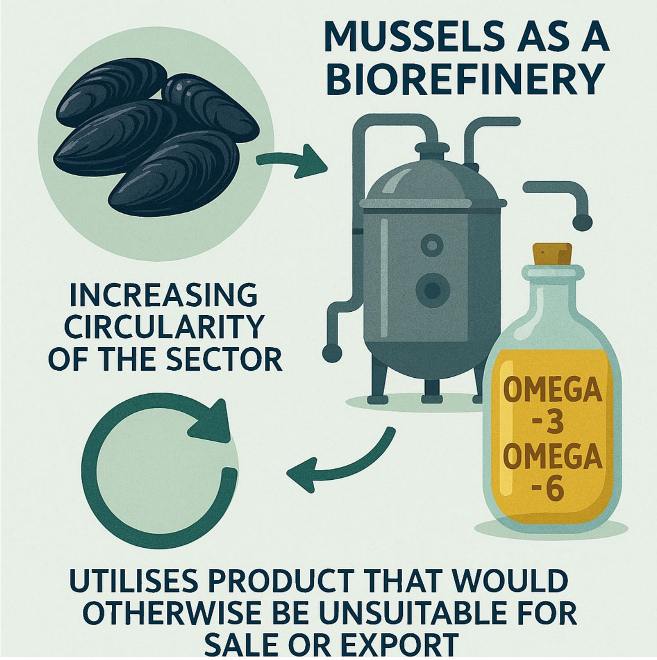
Mussel beds declining

No efforts to restore these critical habitats (despite benefit)

Cited lack of supporting data (Defra; Natural England)

Brexit – huge impact on sector

Can a data driven transformation save sector, transform coastal habitats and result in associated benefits?



Proposed project 2 – EI assisted site selection, environmental impact assessment and performance indices

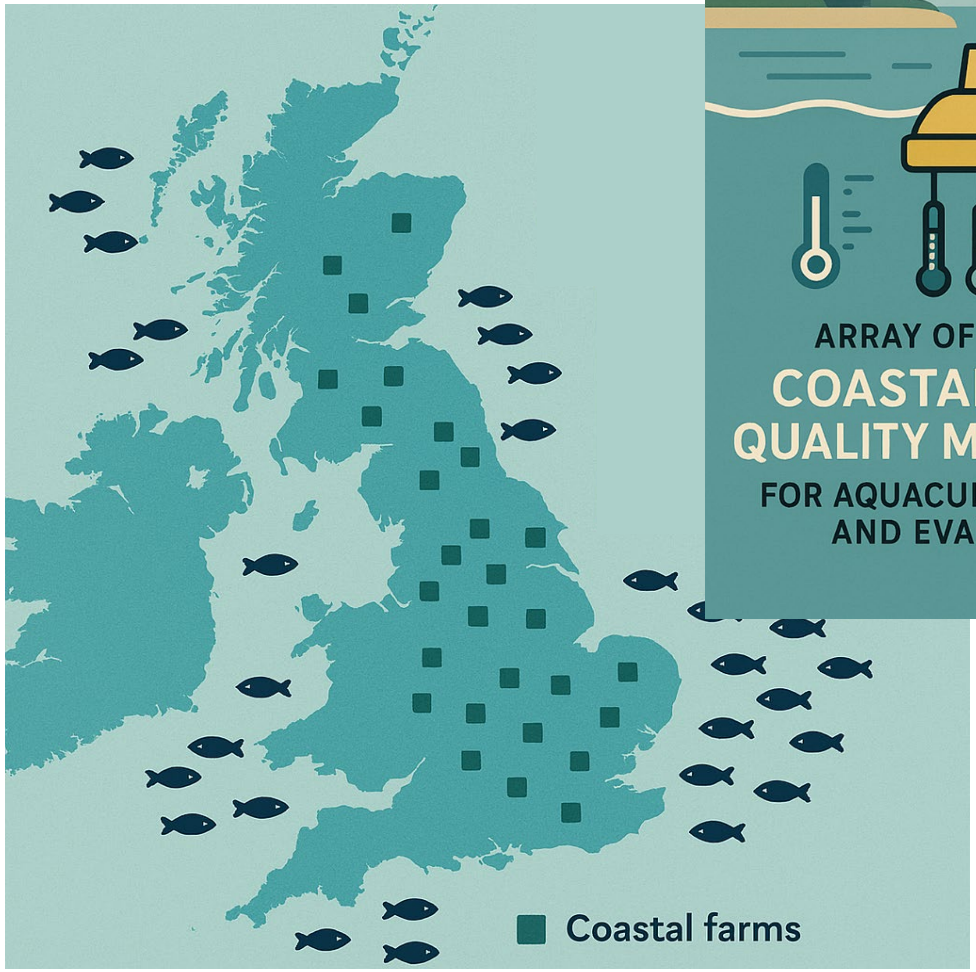
How can we optimise an aquaculture expansion in the UK

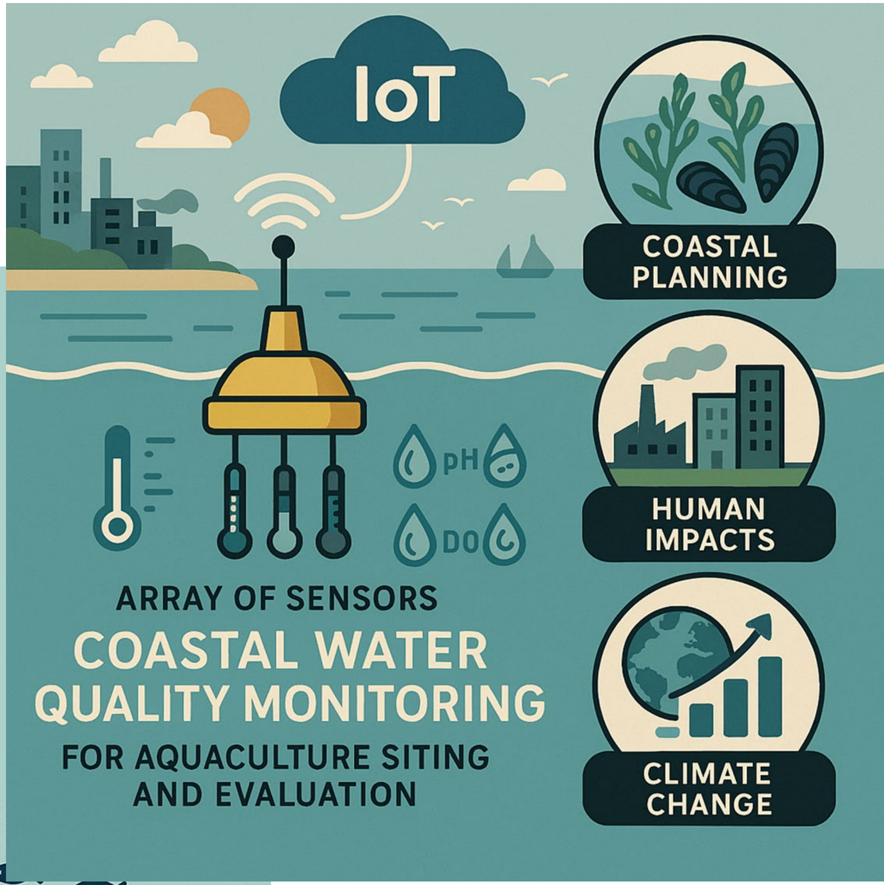
Legislation precautionary and prohibitive

Fear of negative environmental impacts driving production further offshore

No existing solution to optimise site selection for new aquaculture infrastructure (in-shore, coastal, land-based)

Could EI develop a decision tool solution to predict ideal sites for siting aquaculture, as well as monitor impacts based on environmental data





Proposed project 3 – Blue/green transformation, integrating renewables and extractive aquaculture for ecosystem benefit

Green energy expansion critical to ensure we can return within planetary boundaries

With more examples or marine and coastally sited energy infrastructure – poses a potential conflict

Nonetheless – increased hard infrastructure offers opportunity for efficient space use via co-location of sustainable seafood production

What data solutions are required to foster optimal co-location of extractive aquaculture and energy generation, for maximal environmental benefit?

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Please discuss ……

Wider barriers to UK aquaculture expansion

Public Perception
Understanding of sustainable seafood and value of aquaculture

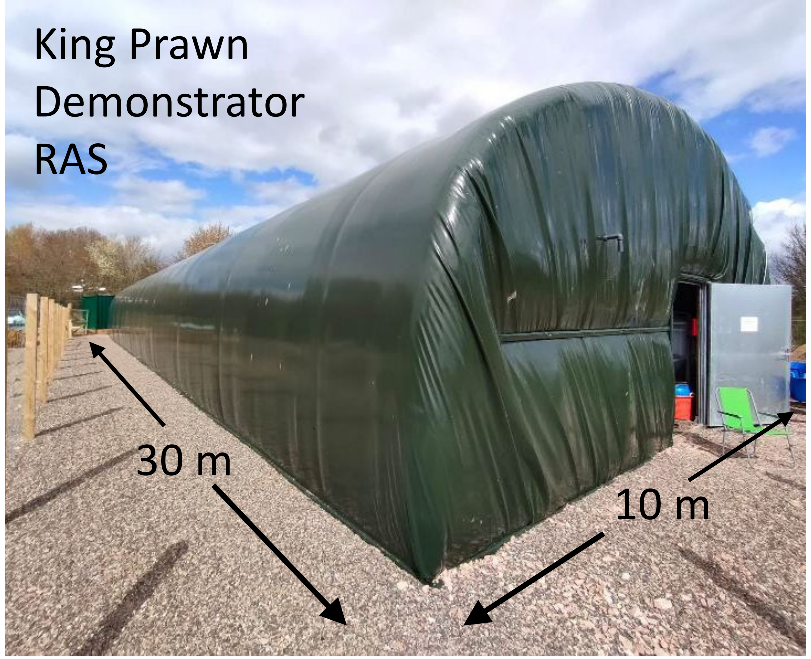
Reliable Supply of Seed
Access to UK-based, biosecure source of larvae

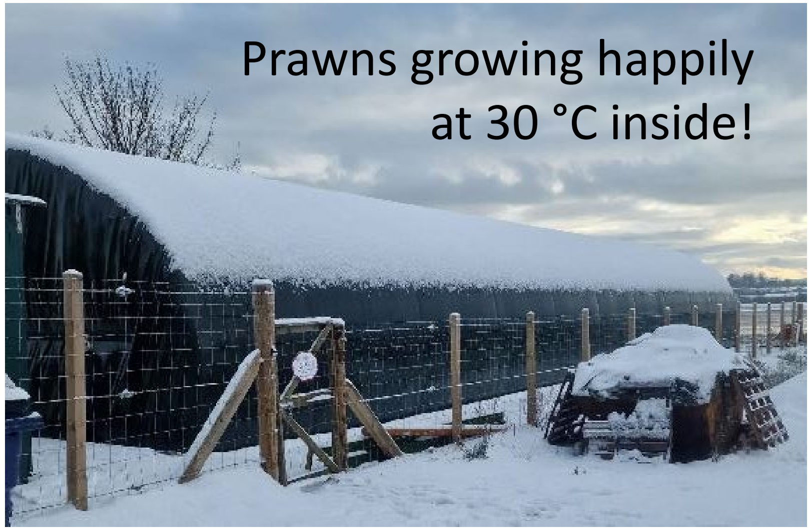
Education
Availability of suitably trained workforce

Regulation
Suitable legislation to support and promote novel production sectors

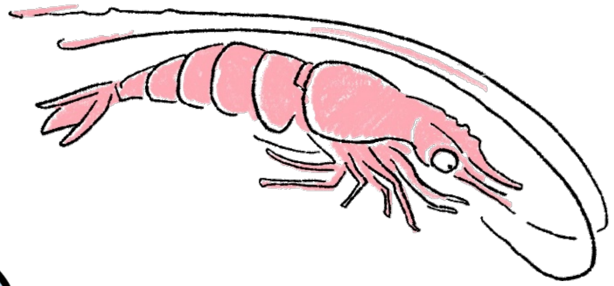
Space for cross sector R&D
Foster industry-academia collaboration & innovation

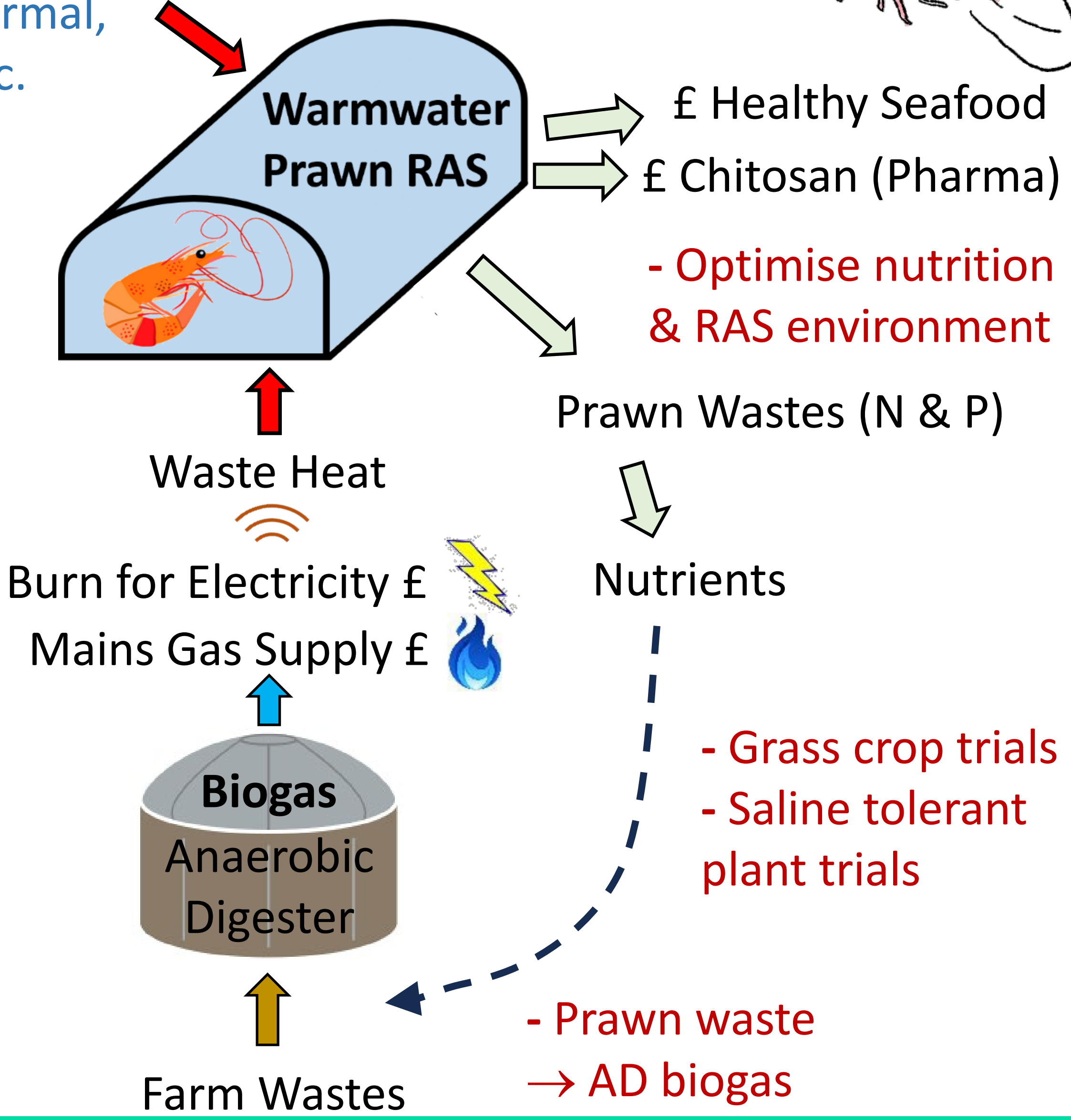
National exemplar: Land-based prawn production





Other Renewable Heat/Energy:
Data Centres, Geothermal,
Solar, Wind, Hydro etc.



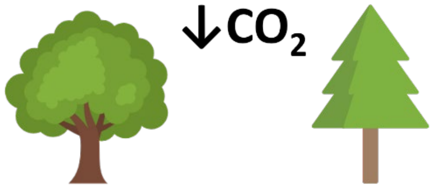


National exemplar: Land-based prawn production

“Public Money for Public Goods”

(Nature Positive Food Systems)

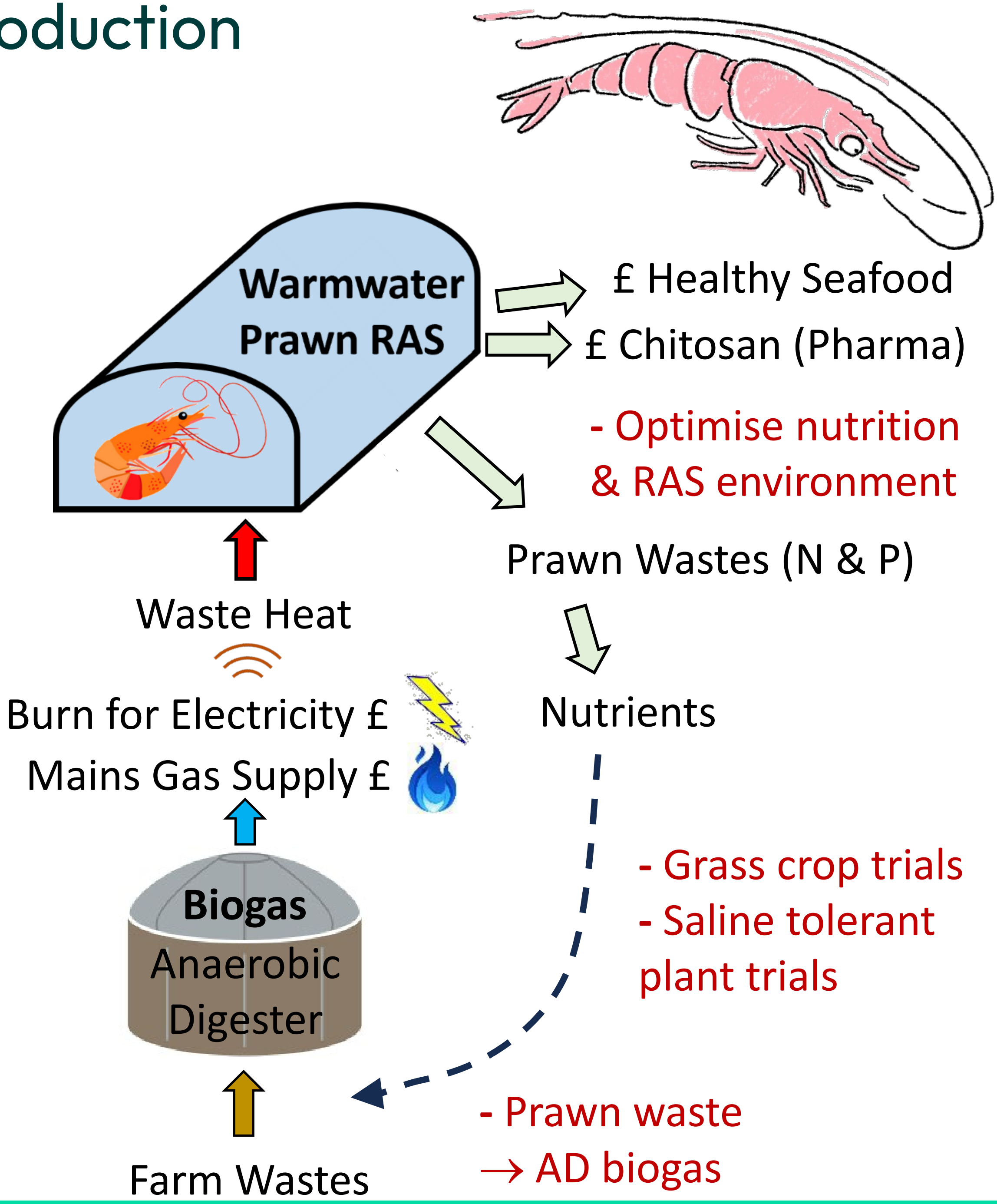
CO_2 removal



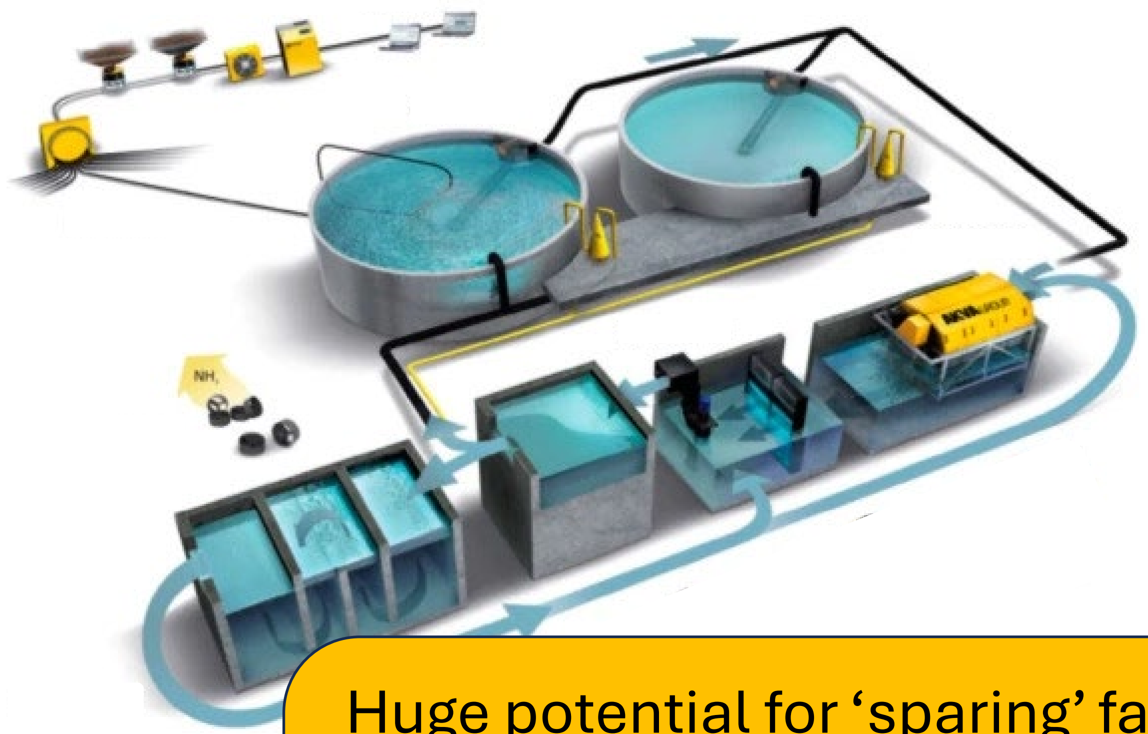
New Agriculture Act
(25YEP)

Biodiversity

Flood Risk



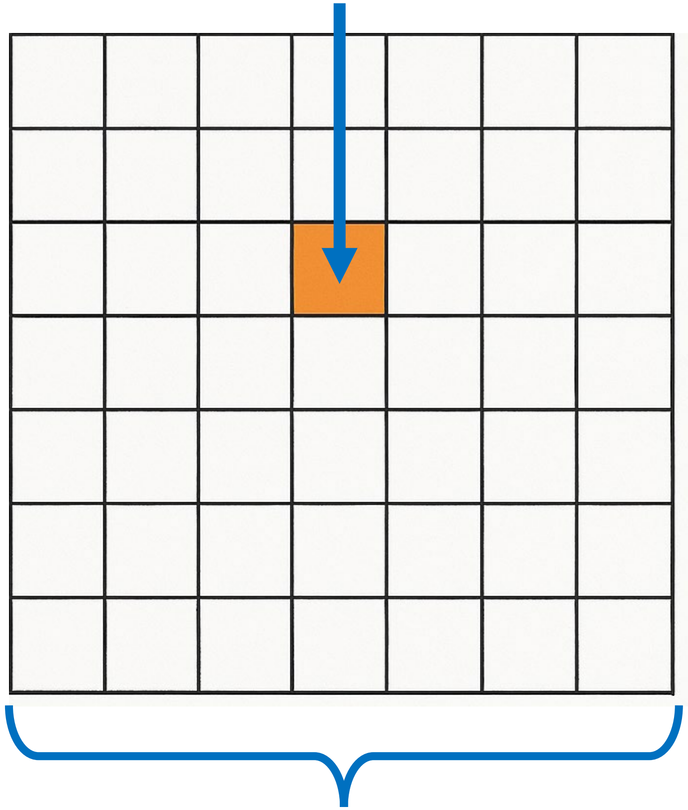
Seafood RAS on UK farmland - a possible solution



Huge potential for 'sparing' farmland for conservation (or other environmental improvements)

...without reducing food production

This area of King Prawn RAS...



...generates as much food as this area (50x more) of beef livestock (and it's lower in fat)

University of Exeter

AI for management approaches in sustainable farming

@ExeterFood and ExeterEI Networks Workshop

Markus Mueller
Email: m.mueller@exeter.ac.uk

28th November 2025

Automation in farming (low- to high-tech)

University of Exeter

Physical Technologies:

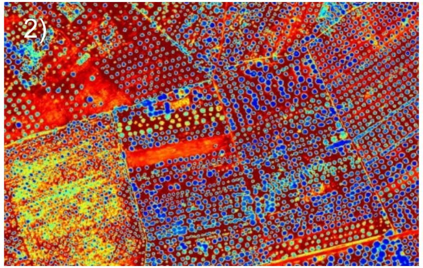
- From irrigation technologies which are 1,000s of years old;
- over automated tractors or other vehicles for tilling, weeding, harvesting;
- to “precision agriculture” robots and drones, e.g., for pesticide application.

Images and credits:
1) Historical Irrigation System at l'Horta de València, Spain, FAO.
2) Automated vine pruner, Wall-Ye.
3) Automated tractor “Robotti LR”, AgroIntelli.
4) Drone spraying systems “Agras”, DJI.

Automation in farming (low- to high-tech)

Digital Technologies:

- Sensors and sensing: from soil moisture and nutrient level monitoring to satellite/aerial image-based analysis for weather forecasting or crop disease diagnosis;
- Internet of Things (IoT): networks of connected devices for real-time and spatially distributed data collection;
- Genetics: from selective breeding to gene editing.
- Decision support: optimising operations and yield, planning of land use and land use transformation.



Images and credits:

1) Analogue soil moisture meter, SA Products.
2) Aerial hyperspectral and thermal image of orchards, University of Melbourne.
3) Solar-powered sensing station, Communications of the ACM.

Environmental issues of industrial farming

- Land use and land use change, leading to deforestation, biodiversity loss, soil erosion, etc..
- Water use leading to depletion of rivers and aquifers, soil degradation, pollution, etc..
- Monocultures, leading to loss of nutrition and diversity.
- Genetically altered organisms, leading to loss of diversity, increased risks of diseases, food safety, etc..

Images and credits:

1) Corn field, Union of Concerned Scientists/USDA.
2) Farm run-off to waterway, Farming UK.
3) Clouds of dust caused by a fungus on a crop field, Nature.

Some of my work

- Adaptive control designs:
  - Consensus-based control strategies for meta-populations of crop pests;
  - Data-driven model-free learning (e.g., using remote sensing).
- Agent-based modelling:
  - Multi-agent network models for disease spread;
  - GIS- or cell-based agent-based models for resource-consumer models, predator-prey dynamics.
- Sensor and spatial data analysis and modelling.

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Thank you, discussion and questions…

a) What are key objectives in sustainable farming?
b) How can objectives be monitored/measured?
c) What physical and digital tools could enable more sustainable farming practices?
d) How can AI/ML enable sustainable management in farming?