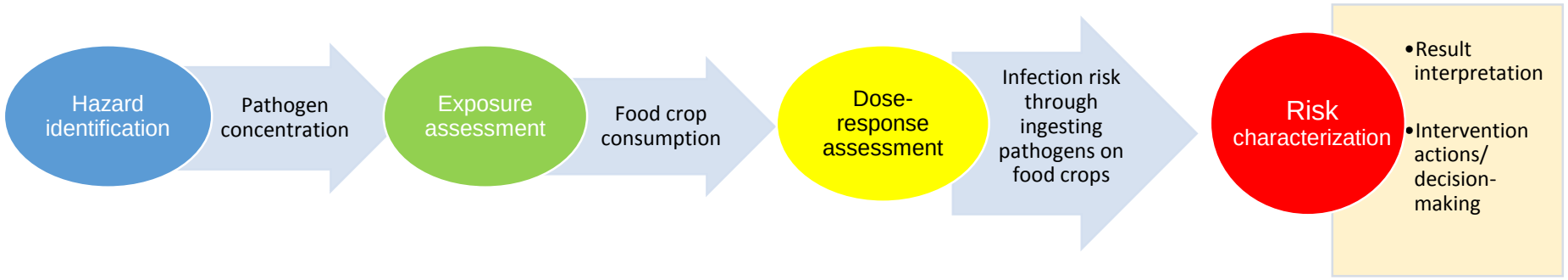
NTS Risk: Quantitative Microbial Risk Assessment

- Is harvested stormwater safe for household applications?



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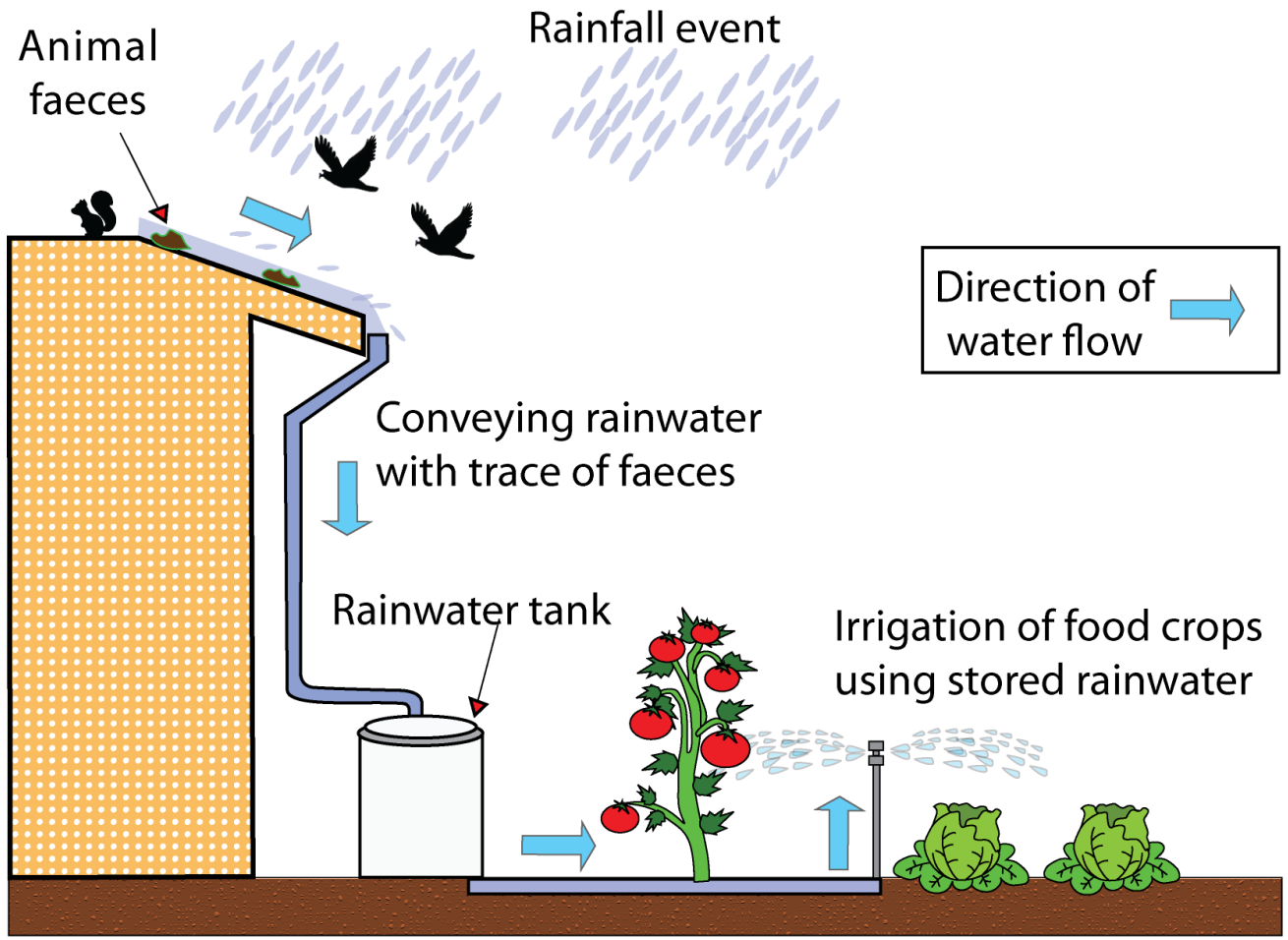
What is the health risk of consuming raw food crops irrigated using untreated rainwater?



- Pathogens in untreated harvested rainwater present potential hazard
- Human eating behavior and pathogens retained on food crops (e.g. lettuce) eaten raw were used to model the risk of infection.
- Infection risk estimated is compared to U.S. EPA annual infection health risk benchmark.

Summary of results

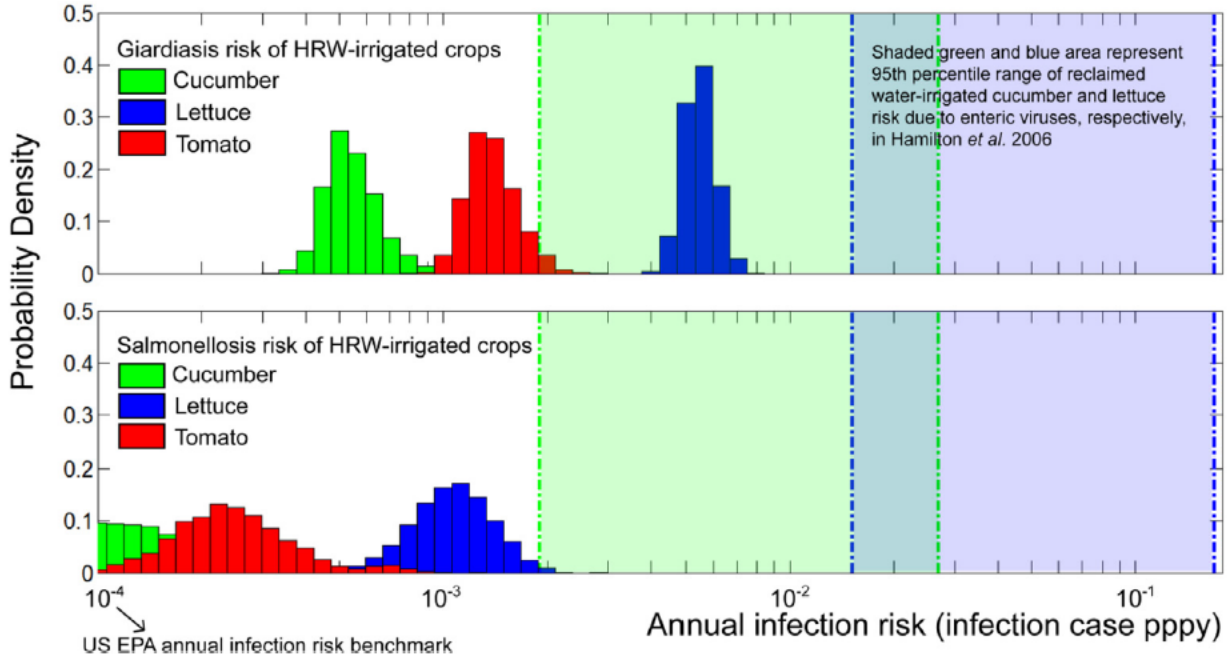


Fig. 3 – Distribution of annual Giardiasis risk (top panel) and Salmonellosis risk (bottom panel) due to consumption HRW-irrigated home produce. The probability density is estimated as normalized histogram. The lower *x*-axis limit is the propounded acceptable annual risk benchmark at ≤1 illness case per 10,000 people per year. Shaded regions in the figure shows the 95th percentile range of the annual risk of reclaimed water irrigated crops estimated by Hamilton et al., 2006).

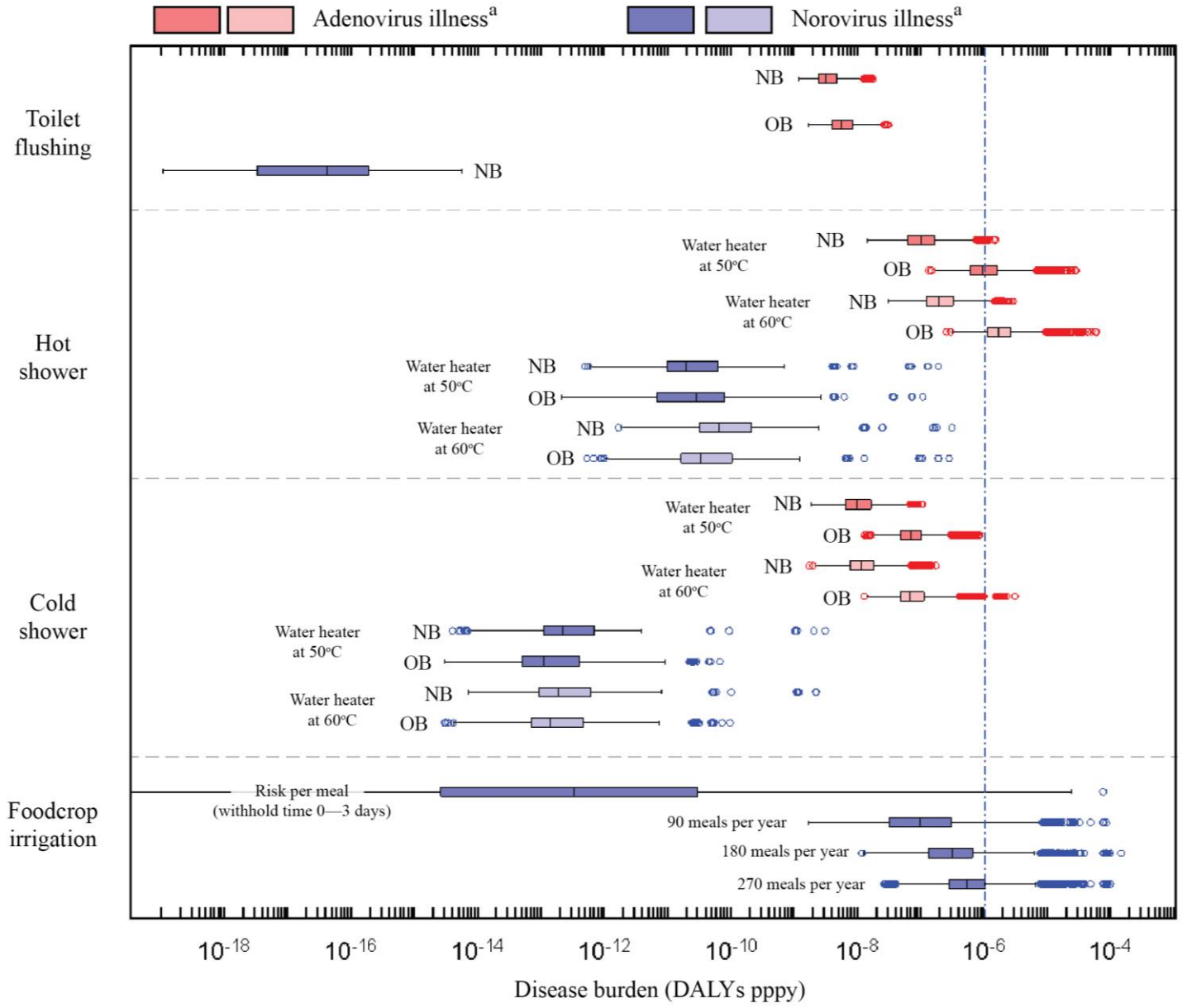
- Compounded annual risk (multiple intake events in a year) is very likely exceeding the U.S. EPA acceptable annual infection risk of ≤10^{-4} case per year

Health risk associated with use of harvested stormwater

- Wetlands are sustainable urban water management tools and can be used for harvesting and treating stormwater
- Wetland-treated stormwater is proposed for non-potable purposes
- Traditional stormwater treatment focuses on nutrients and metal removal. Pathogen removal efficiencies are not fully elucidated.

Wetland for pretreatment of water used in Troup Creek stormwater recycling facilities (Melbourne)

Results: DALYs associated with Harvested Stormwater Use



Summary of Health Risk Studies

- Daily consumption of fresh produce irrigated using harvested rooftop rainwater (HRW) will exceed the annual risk of infection set by the U.S. EPA for drinking water
- However, in comparison with produce irrigated with reclaimed wastewater, the annual infection risk of the former is much lower
- The results argue for reconsideration of current water related health risk benchmark to promote sustainable water practice
- The disability-adjusted life year (DALY) per person per year for household uses of harvested stormwater are below the benchmark set by WHO for most applications
- There is a large range of DALYs for the disease caused by norovirus in the case of crop irrigation due to the uncertainty of infectivity and environmental decay of the virus

Products

- Manuscripts
  - Reevaluation of health risk standards for sustainable water practice through risk analysis of rooftop-harvested rainwater. K. H. Lim, S. Jiang. *Water Research*.47:7273-7286
  - Human and Environmental Health Risks and Benefits Associated with Urban Stormwater Harvesting. S. Jiang, K.Y. Lim, X. Huang, D. McCarthy, A. Hamilton. Submitted to *WIREs Water*.
  - Assessment of public health risk associated with viral contamination in harvested urban stormwater for domestic applications: the link between perceived risk and quantitative risk. K.Y. Lim, A. Hamilton, and S. Jiang. Submitting to *Water Research*.
- Proposal
  - “Managing disease risks associated with stormwater reuse”. In discussion with Andrew Hamilton and David McCarthy for potential submission to ARC Discovery or NHMRC.

NTS Risk: Benthic Animals and GHG Emissions from Constructed Wetlands

- Do chironomids and aquatic oligochaetes enhance benthic N_2O flux?

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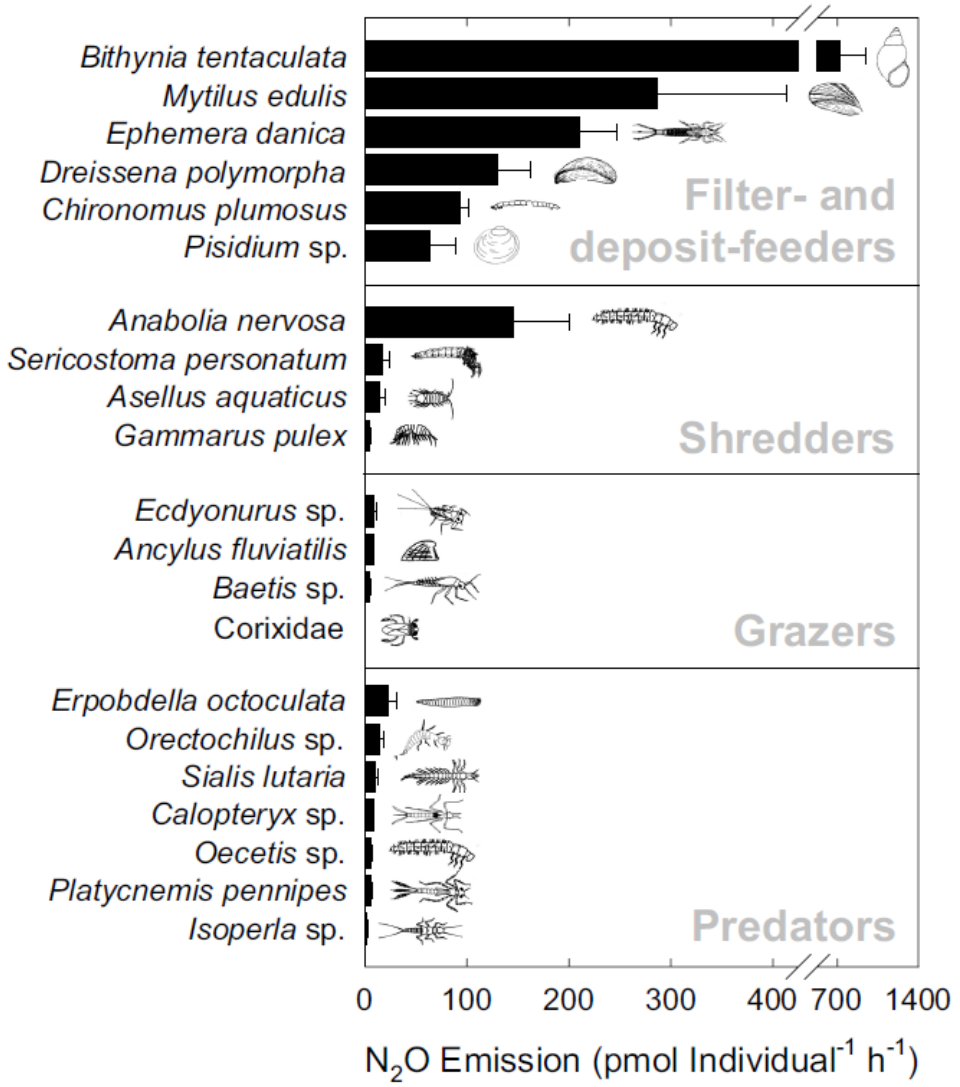
Hypotheses to be Tested

1. Benthic N_2O flux positively correlated to chironomid & oligochaete abundance
2. Higher δ15N near outlet of wetland, reflecting loss of lighter isotopes via denitrification or uptake via assimilation
3. Water/air interface GHG flux (modeled based on gas samples collected near water surface) correlated with benthic flux, higher in golf course ponds

(GHG study motivated by previous lab studies)

- Sediment-feeding invertebrates enhance denitrification & N_2O emission (Stief et al 2009 *PNAS*)



GHG Measurement Approach

- Aquatic sediment cores collected from 10 sites, four cores per site, two times per year:
  - 5 constructed wetlands, 5 golf-course ponds
  - Cores are returned to the laboratory, incubated, and greenhouse gas fluxes (CO_2, CH_4, N_2O) measured over time

Preliminary GHG Results

- Summer GHG flux in constructed wetlands ≥ golf courses
- Higher δ15N in outlets reflects N assimilation & denitrification within the wetland

Perran Cook sampling Yarra River sediment Photo: Simon Schluter, Brisbane Times

Implications: GHG Studies

- Results will clarify influence animals have in the production of GHG from wetlands and N-processing
- Management implications—improves estimates for emission and seasonality of GHGs from constructed wetlands (inverts have seasonal patterns)
- Management strategies?
- Data collection is continuing