Parasites warning us on ecosystem changes

The case study of fish parasites in anthropogenically impacted Lake Victoria

Tiziana Gobbin, Maarten Van Steenberge, Nathan Vranken, Maarten PM Vanhove

International Symposium on Fish Parasites
Mérida, 20-24 January 2025

Global change

Global change & populations

- Distribution shifts
- Population declines and extinctions
- Few invasions

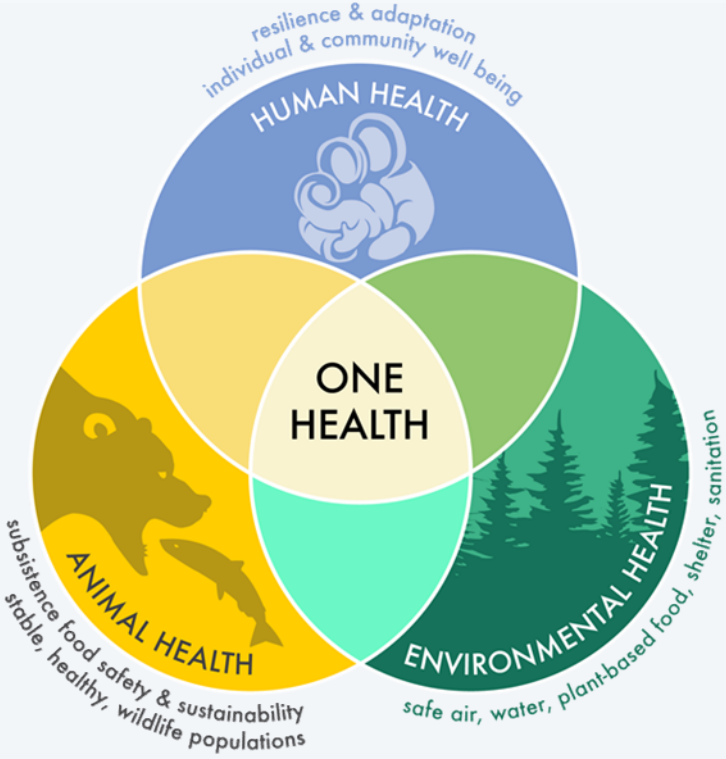
- in plants
- in animals

free-living

(metazoan) parasites?

Expected to be affected, but direction of change is unclear

One Health & Parasites



What can we learn from wildlife parasites?

- **Status of ecosystem health**
  An ecosystem rich in parasites is an healthy ecosystem
- **Link between habitat degradation and spillovers**
  If an ecosystem changes, then host-parasite interactions change too

  Not only human-nature direct contact, but also human activities
  (main predictor of spillovers: change in land use)

Human-induced ecosystem changes

Many parasitic diseases are linked to water

Anthropogenic changes

- Water eutrophication
- Species invasions
- Overfishing
- Pollution

Nile perch
(*Lates niloticus*)

IISD – Experimental Lakes Area ELA

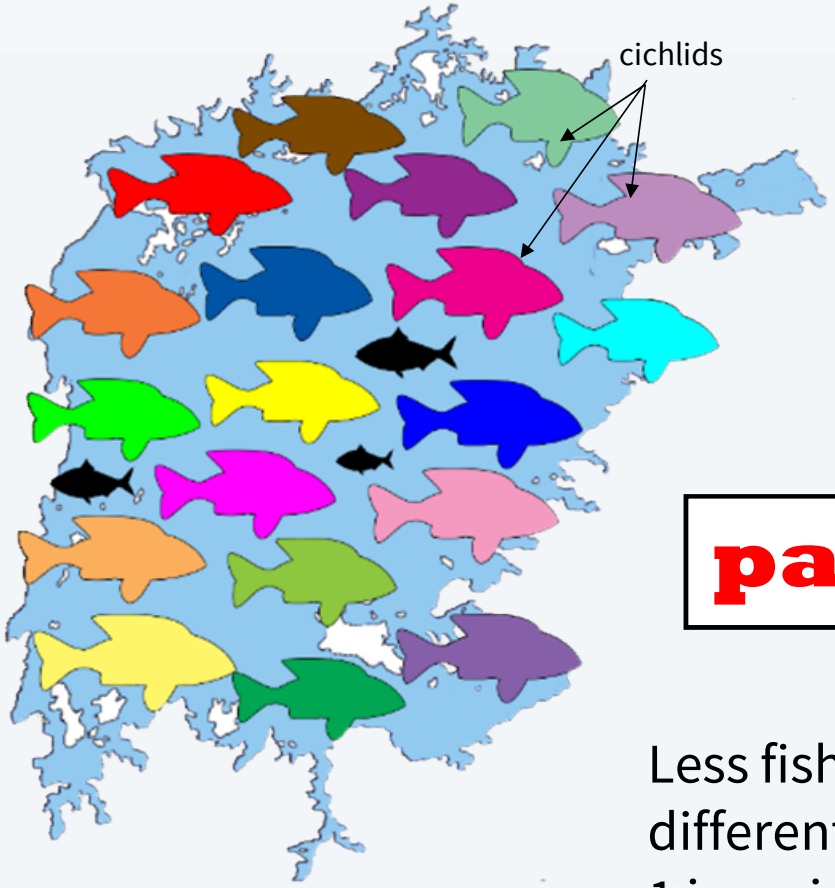
Lake Victoria

Lake Victoria

- African Great Lake (~60’000 km^2)
- Well studied system (especially fishes)
- Good model for anthropogenic impact on wetlands:

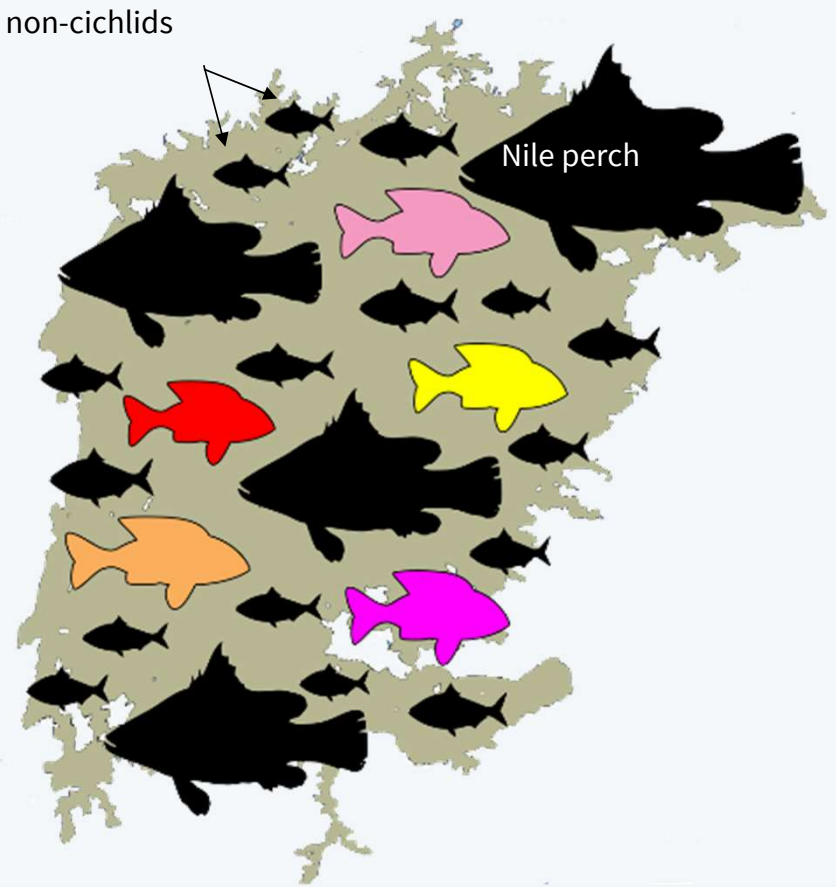
  human perturbations since 1980s

Lake Victoria



parasites?

Less fish species
different fish community
1 invasive predator

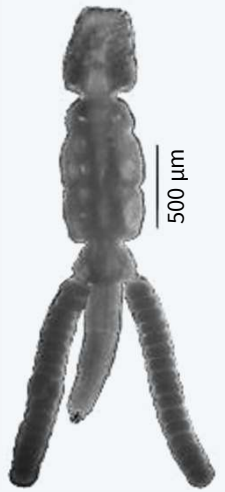


Study design

Before-after impact study, using historical and recent natural collections

13 cichlid fish species screened for gill macroparasites

Gill parasites



Lamproglena monodi

Ergasilus lamellifer

copepods
(crustaceans)

Gill parasites

4 species new to science!
(Gobbin et al. 2024)

Lamproglena monodi

Ergasilus lamellifer

copepods
(crustaceans)

C. nyanza

C. pseudodossoui

C. furu

C. vetusmolendarius

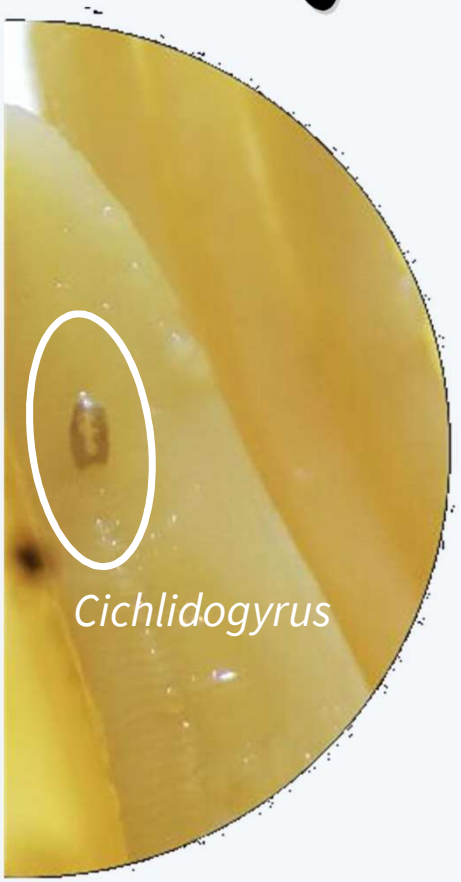
C. longipenis

C. bifurcatus

Gyrodactylus sturmbaueri

Cichlidogyrus

monogeneans
(flatworms)

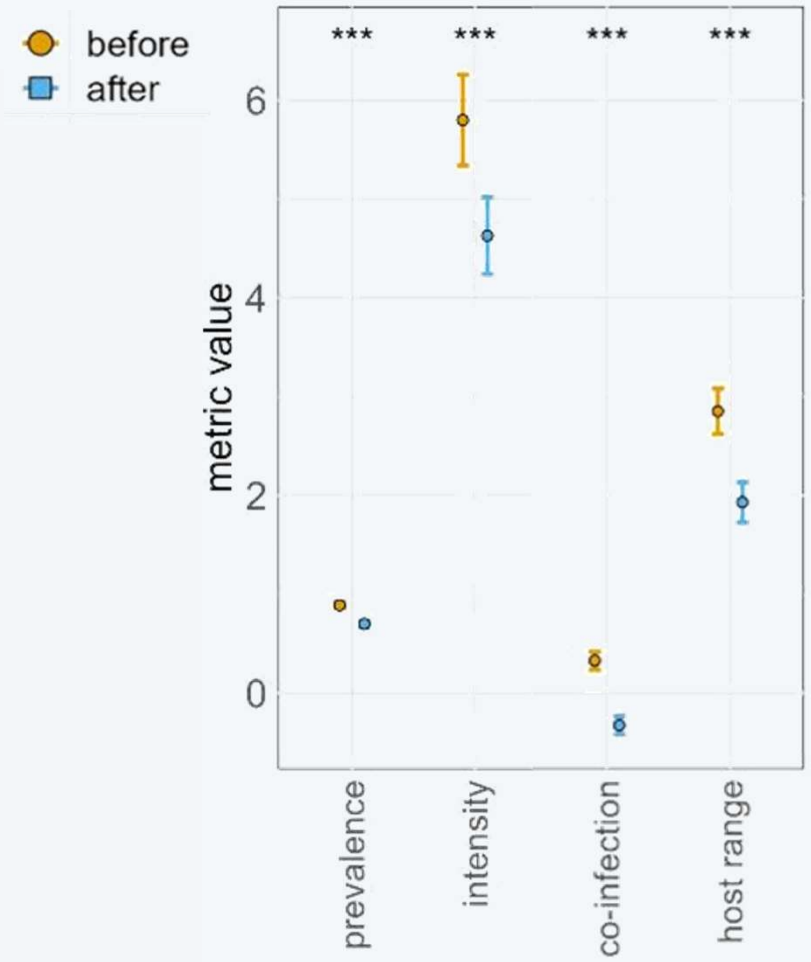


One Health & gill parasites

Advantages of One Health research on gill parasites

- Direct life cycle → no confounding effects
- High host specificity → spillovers are meaningful
- Ethics → not a threat to humans
- Infection parameters → intensity, zero counts, prevalence, co-infections, H-P network
- Collection-based research → cheap, large datasets, 1 host individual = 1 parasite community

Results: changes in Lake Victoria

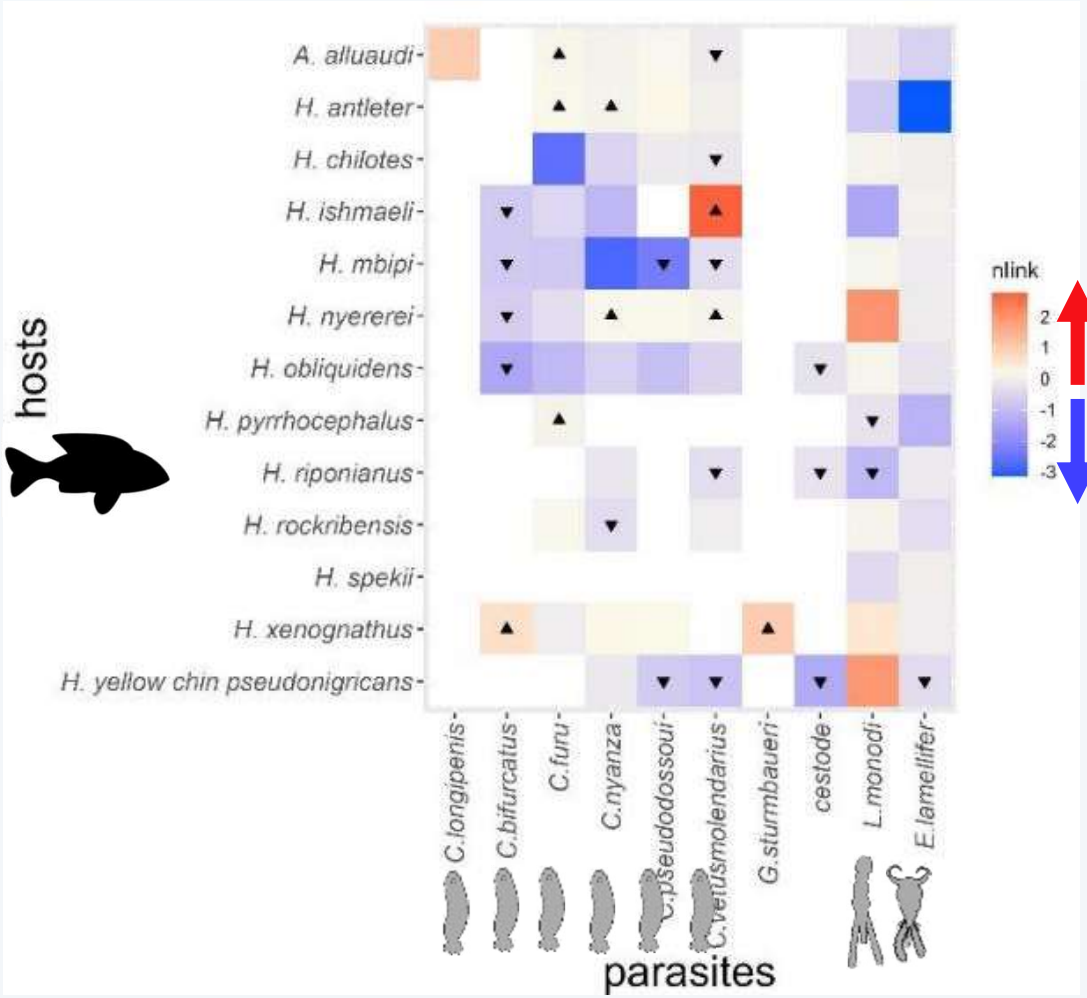


After ecosystem perturbations in Lake Victoria:

- Fewer fish were infected
  (prevalence decreased)
- Fish were infected by a lower number of parasites
  (intensity decreased)
- Co-infections became less frequent
  (decreased occurrence of ≥2 parasite species on the same host individual)
- Parasite species infected less host species
  (host range decreased)

Hurdle model, GLM

Results: changes in Lake Victoria



Spillovers

▼ some parasites disappeared from some host species, and

▲ colonized few new host species that they did not infect before.

Perturbations may favor spillovers (network rearrangement)

Disentangling the causes

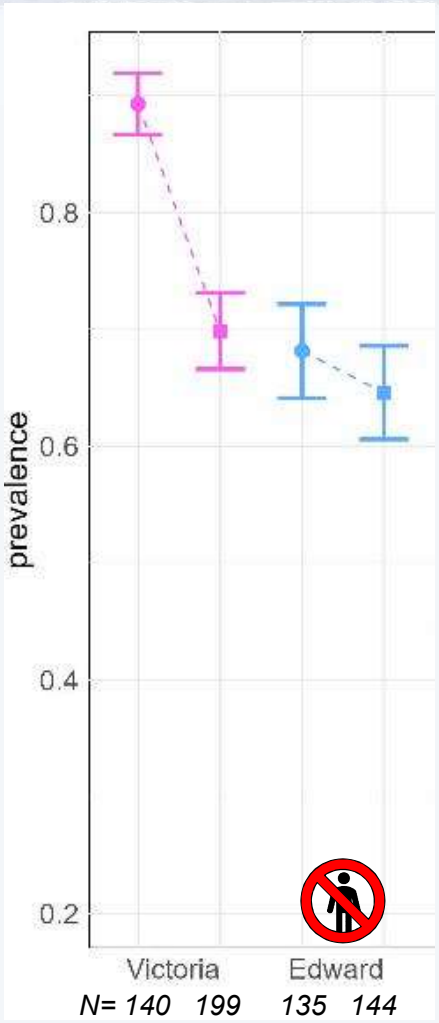
Are these changes in parasite infections really due to human perturbations?

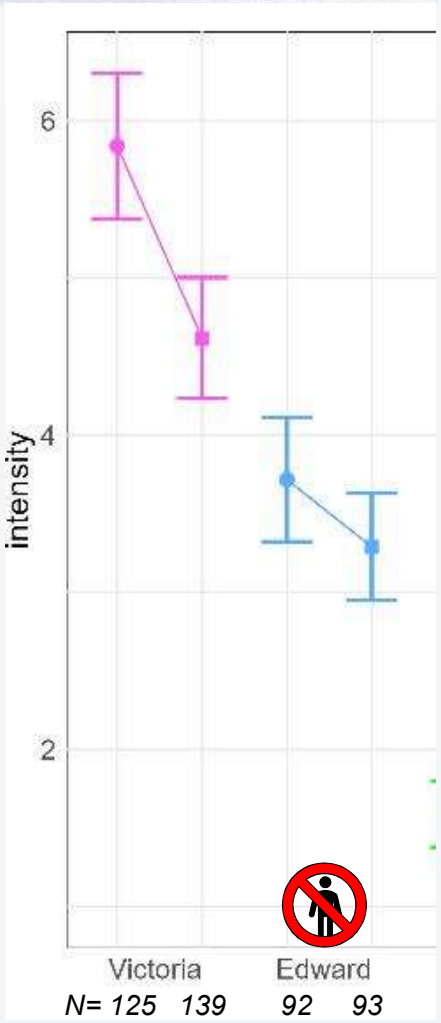
Lake Edward

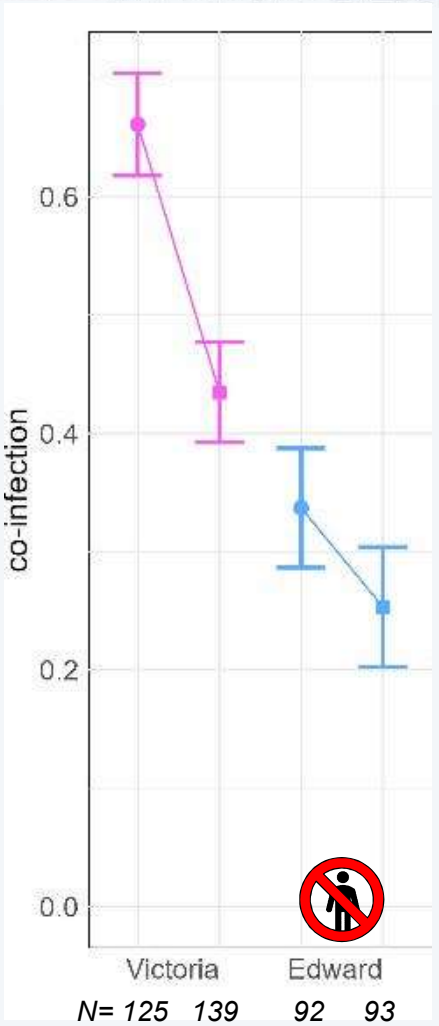
- (almost) pristine ecosystem
- close to Victoria
- harbouring cichlids from the LVictoria radiation superflock

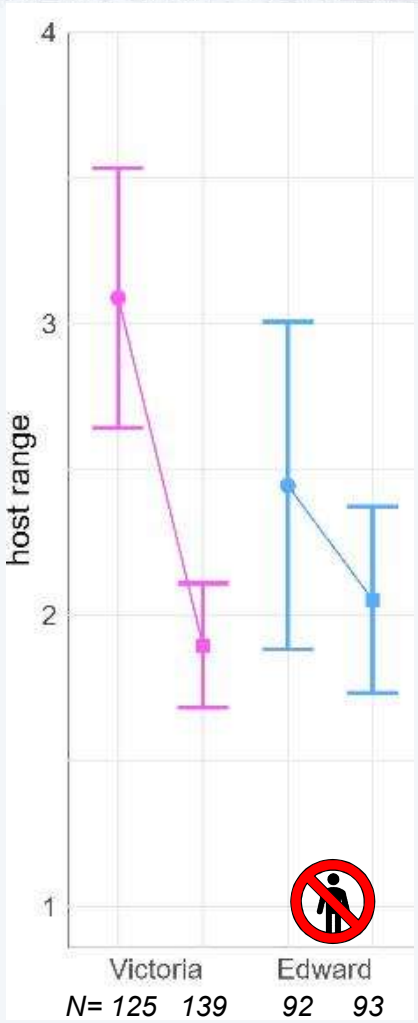
→ Test for temporal changes in parasitism in Lake Edward

Disentangling the causes









Lake Edward: unchanged

→ changes in parasitism in LVictoria are due to human perturbations, rather than to natural fluctuations

Disentangling the causes

What are the causes of the changes in parasitism in Lake Victoria?

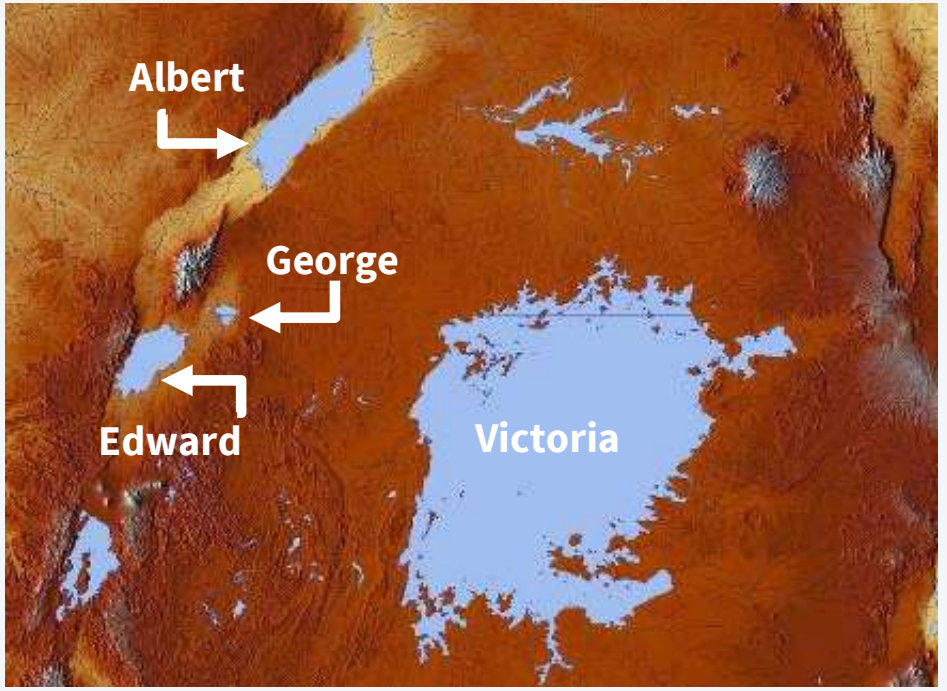
Lake Albert

- Naturally high predation

Lake George

- Naturally eutrophic

- close to Victoria
- harbouring cichlids from the LVictoria radiation superflock



Disentangling the causes

What are the causes of the changes in parasitism in Lake Victoria?

Lake Albert

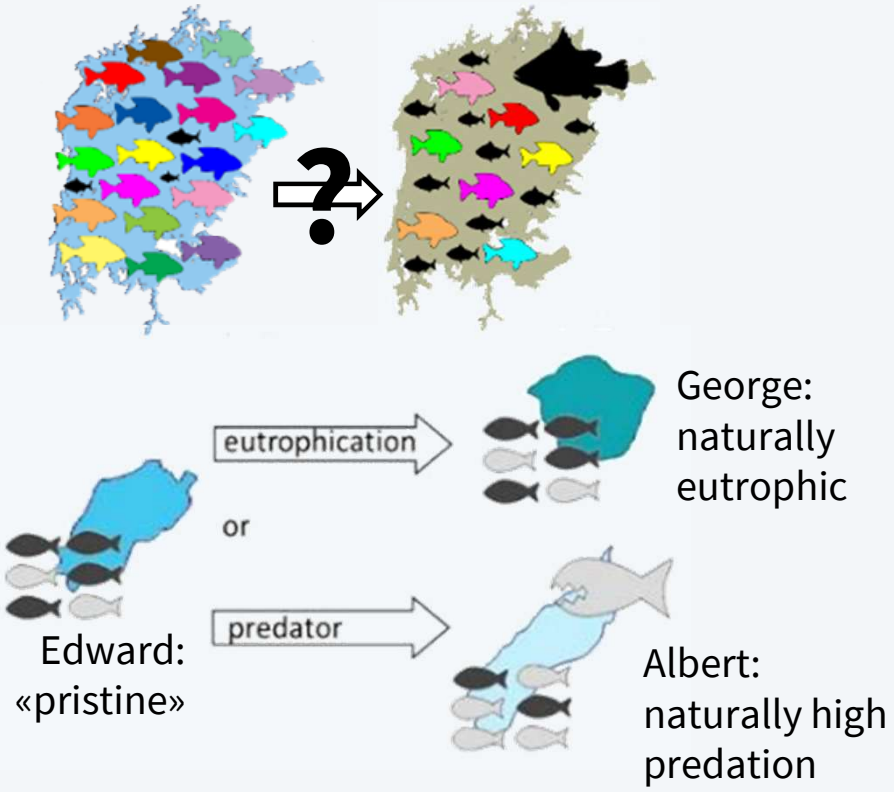
- Naturally high predation

Lake George

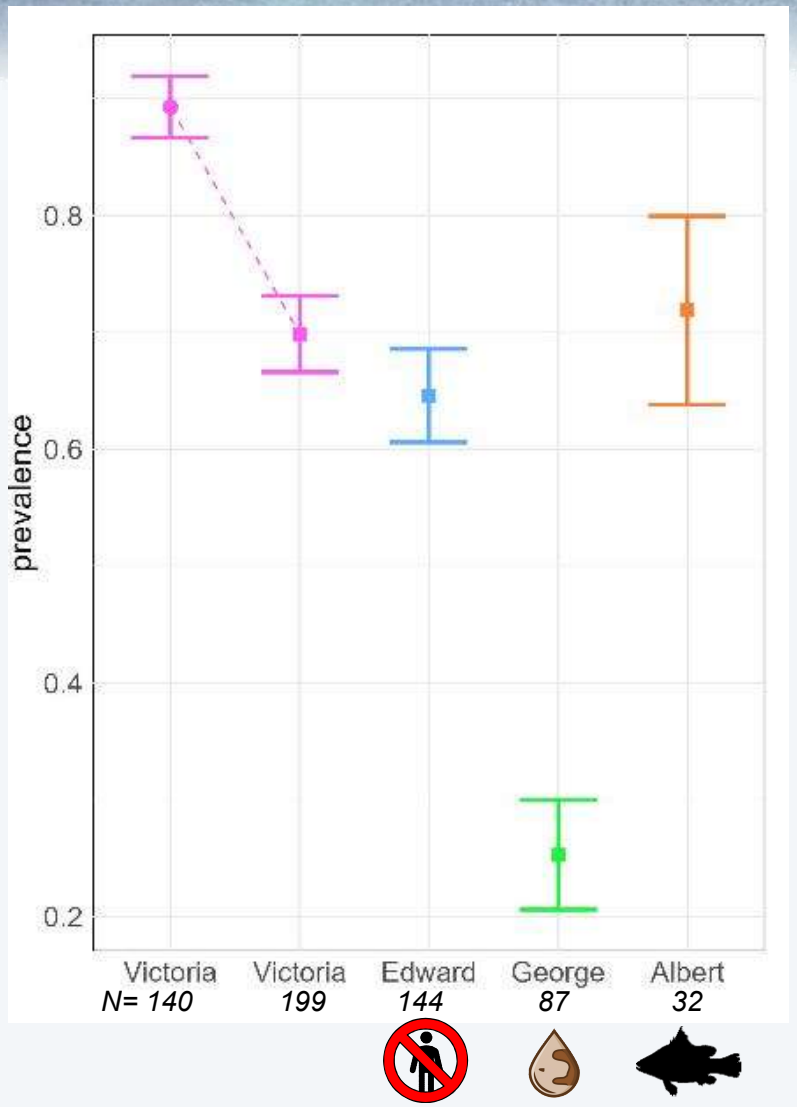
- Naturally eutrophic

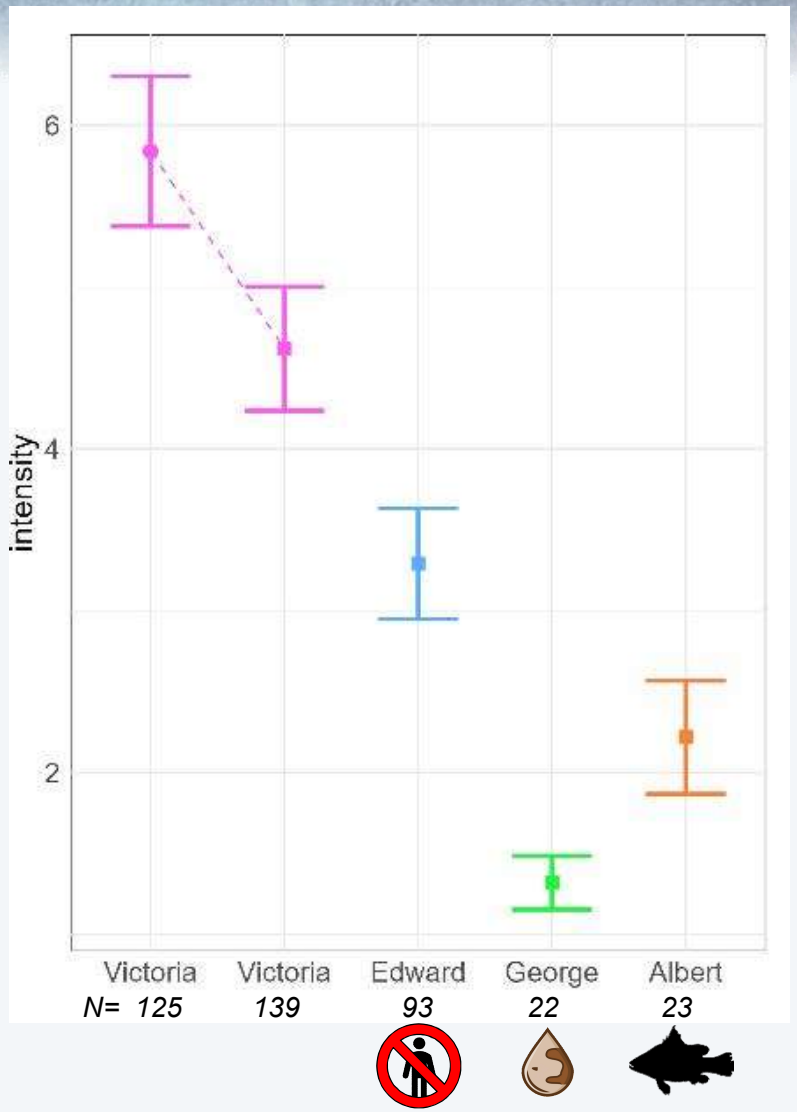
- close to Victoria
- harbouring cichlids from the LVictoria radiation superflock

→ **Space-for-time approach**



Disentangling the causes

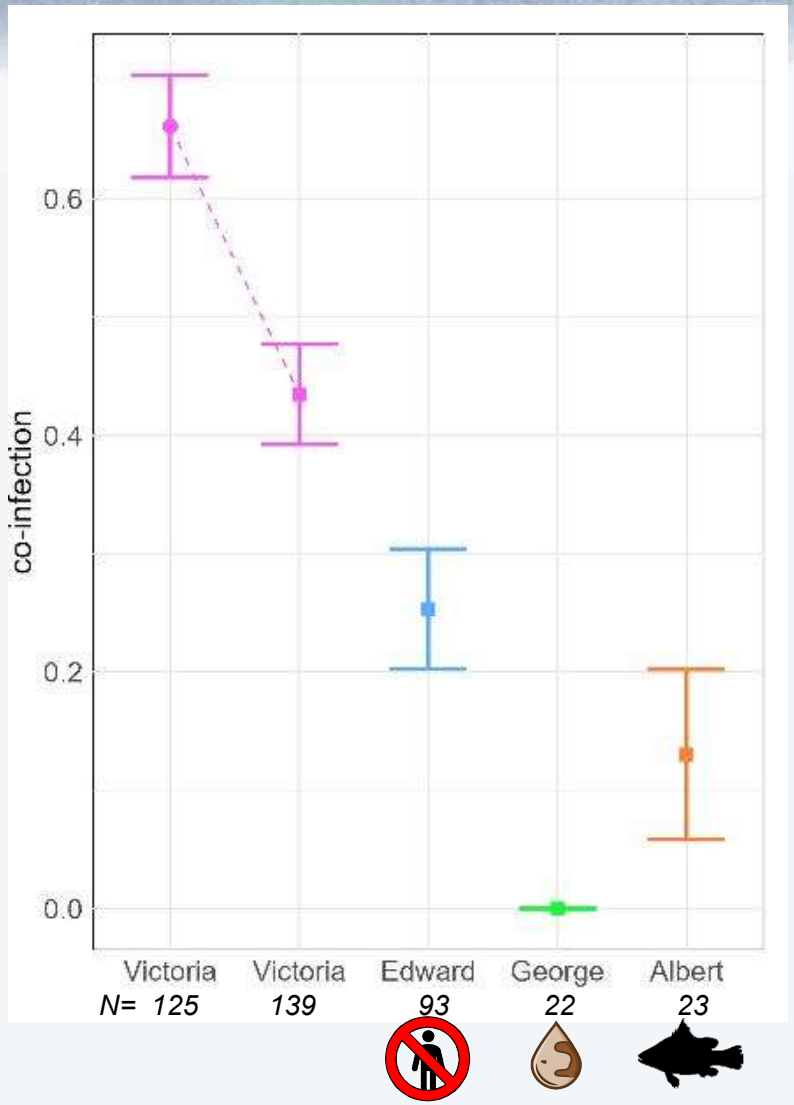


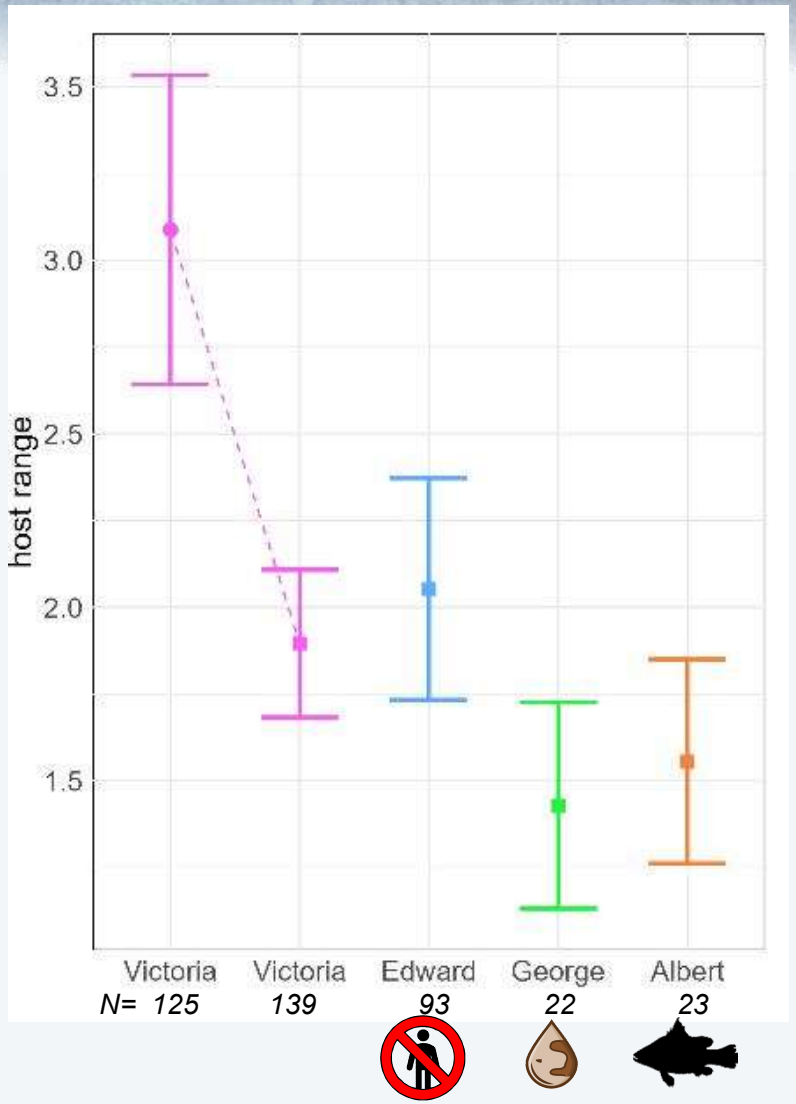


Changes in parasitism in Lake George resemble to changes in Lake Victoria

→ Eutrophication could have driven observed changes in parasitism in Lake Victoria

Disentangling the causes





Changes in parasitism in Lake George resemble to changes in Lake Victoria

→ Eutrophication could have driven observed changes in parasitism in Lake Victoria

Conclusions

- Parasites intensity, prevalence, and co-infections decreased after perturbations in Lake Victoria
- Ecosystem perturbations can favor spillovers: parasites infected fewer and different host species
- These changes are not due to natural fluctuations, but may have been due to water eutrophication

Parasites as sentinels:

- to provide an early warning for host switches
- to monitor ecosystem health

Swiss National Science Foundation

UHASSELT

IUCN SSC PARASITE Specialist Group

fwo

natural sciences .be

Gracias

Ichthyo-parasitological team @ Hasselt University (B)

Royal Museum for Central Africa (B)
Royal Belgian Institute of Natural Sciences (B)
Naturalis Biodiversity Center (NL)
EAWAG, Swiss Federal Institute of Aquatic Science and Technology (CH)

tiziana.gobbin@uhasselt.be
https://tizianapaolagobbin.wordpress.com

- **TP Gobbin**, M Van Steenberge, N Vranken, MPM Vanhove (2024) **Worms of change: anthropogenic disturbance changes the ectoparasite community structure of Lake Victoria cichlids**. Preprint available on bioRxiv doi: 10.1101/2024.04.14.589059

- **TP Gobbin**, MPM Vanhove, O Seehausen, ME Maan, and A Pariselle (2024), **Four new species of *Cichlidogyrus* (Platyhelminthes, Monogenea, Dactylogyridae) from Lake Victoria haplochromine cichlid fishes, with the redescription of *C. bifurcatus* and *C. longipenis*.** Parasite 31(46). https://doi.org/10.1051/parasite/2024039

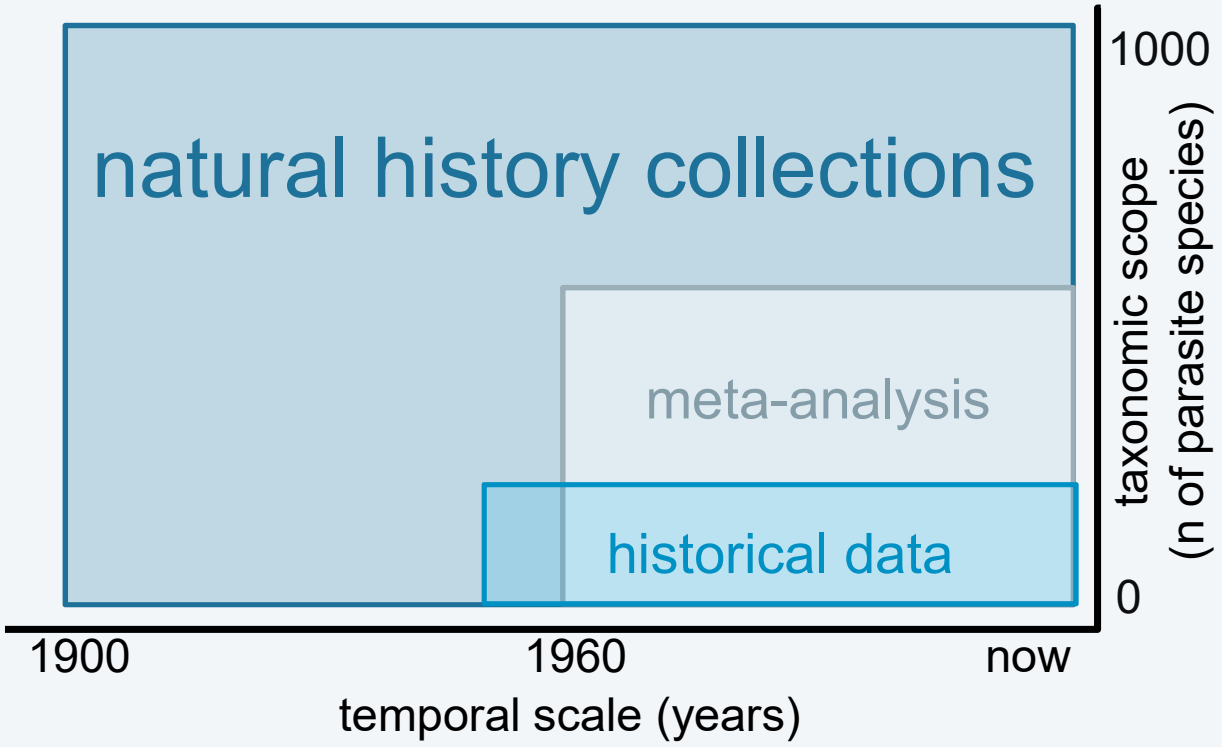
- **TP Gobbin**, MPM Vanhove, R Veenstra, ME Maan, and O Seehausen (2023). **Variation in parasite infection between replicates of speciation in Lake Victoria cichlid fish.** Evolution 77(7), 1682-1690. doi:10.1093/evolut/qpad080

- **TP Gobbin**, MPM Vanhove, A Pariselle, ME Maan, and O Seehausen (2020). **Temporally consistent species differences in parasite infection but no evidence for rapid parasite-mediated speciation in Lake Victoria cichlid fish.** Journal of Evolutionary Biology 33(5): 556. doi:10.1111/jeb.13615

- **TP Gobbin,** MPM Vanhove, O Seehausen, and ME Maan (2020). **Microhabitat distributions and species interactions of ectoparasites on the gills of cichlid fish in Lake Victoria, Tanzania.** International Journal for Parasitology 51(2-3), 201-204. doi:10.1016/j.ijpara.2020.09.001

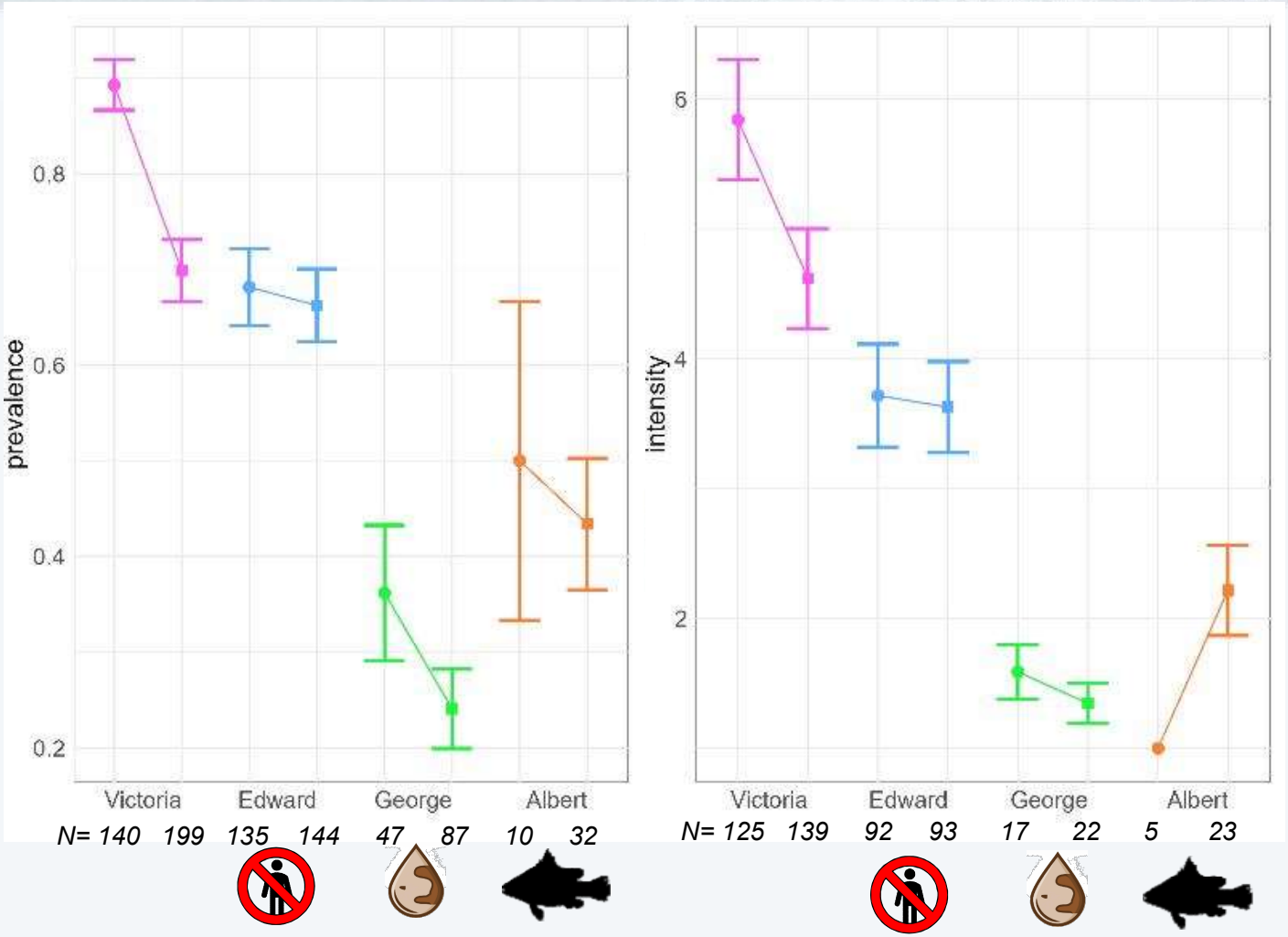
- **TP Gobbin**, R Tiemersma, G Leone, O Seehausen, and ME Maan (2020), **Patterns of ectoparasite infection in wild-caught and laboratory-bred cichlid fish, and their hybrids, implicate extrinsic rather than intrinsic causes of species differences in infection**, Hydrobiologia 848(16), 3817-3831. doi:10.1007/s10750-020-04423-7.

Collection-based research



(Wood & Vanhove, 2022)

Disentangling the causes

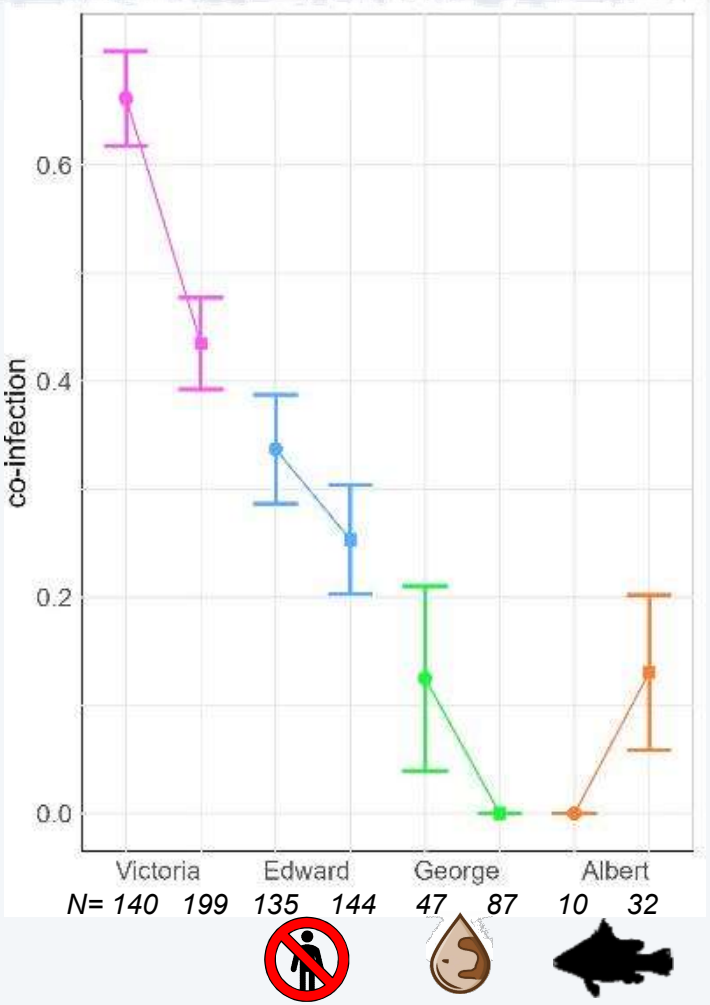


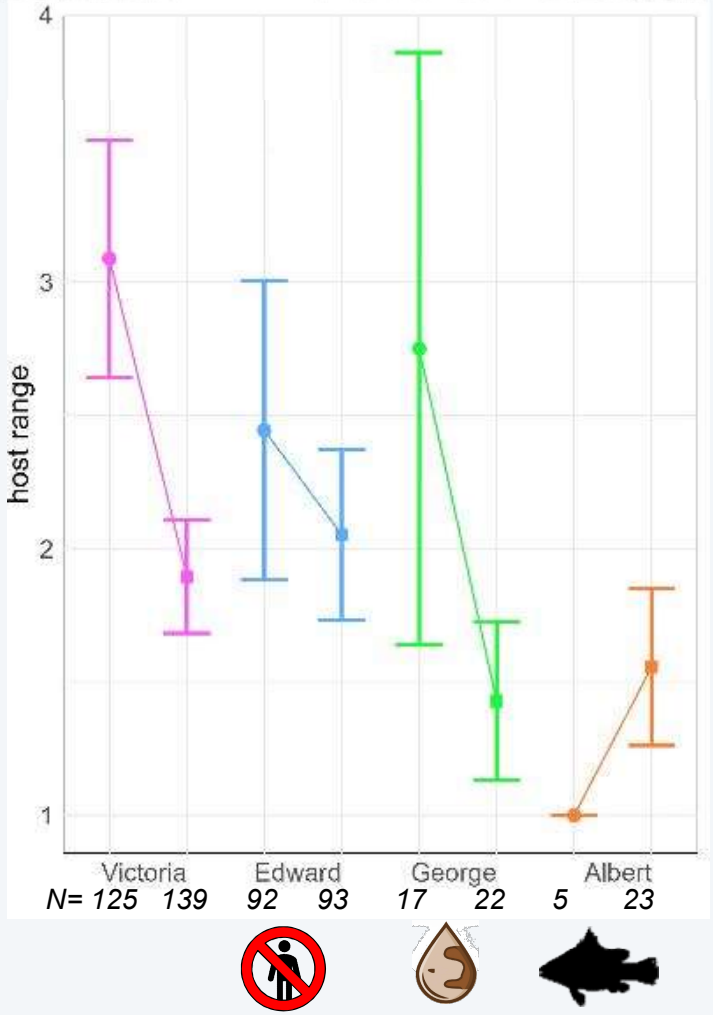
Lake Edward: unchanged

→ changes in parasite infections in LVictoria are due to human perturbations (not to natural fluctuations)

Changes in parasitism in Lake George resemble to changes in Lake Victoria

Disentangling the causes

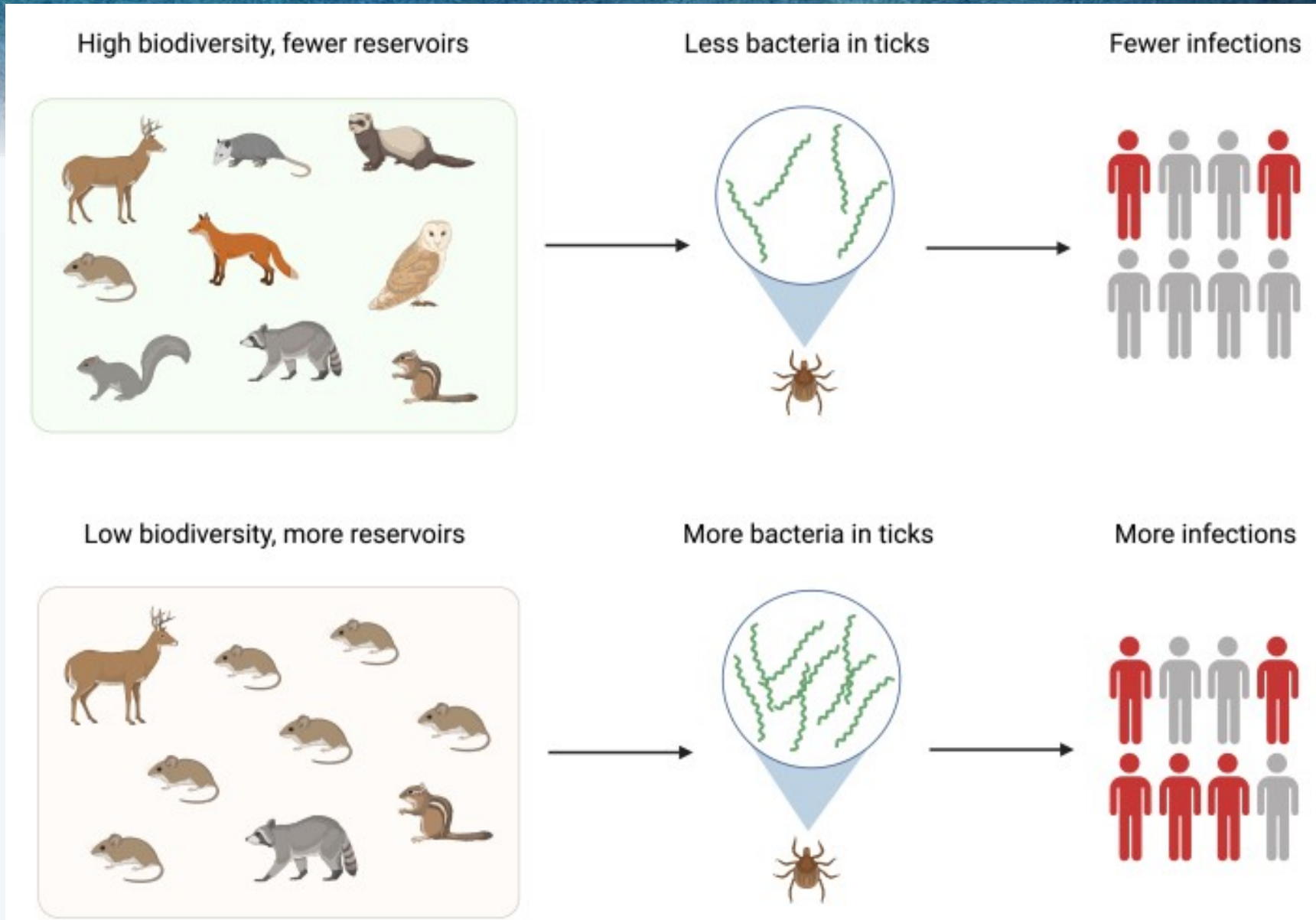




Lake Edward: unchanged

→ changes in parasite infections in LVictoria are due to human perturbations (not to natural fluctuations)

Changes in parasitism in Lake George resemble to changes in Lake Victoria


High biodiversity, fewer reservoirs
Less bacteria in ticks
Fewer infections
Low biodiversity, more reservoirs
More bacteria in ticks
More infections