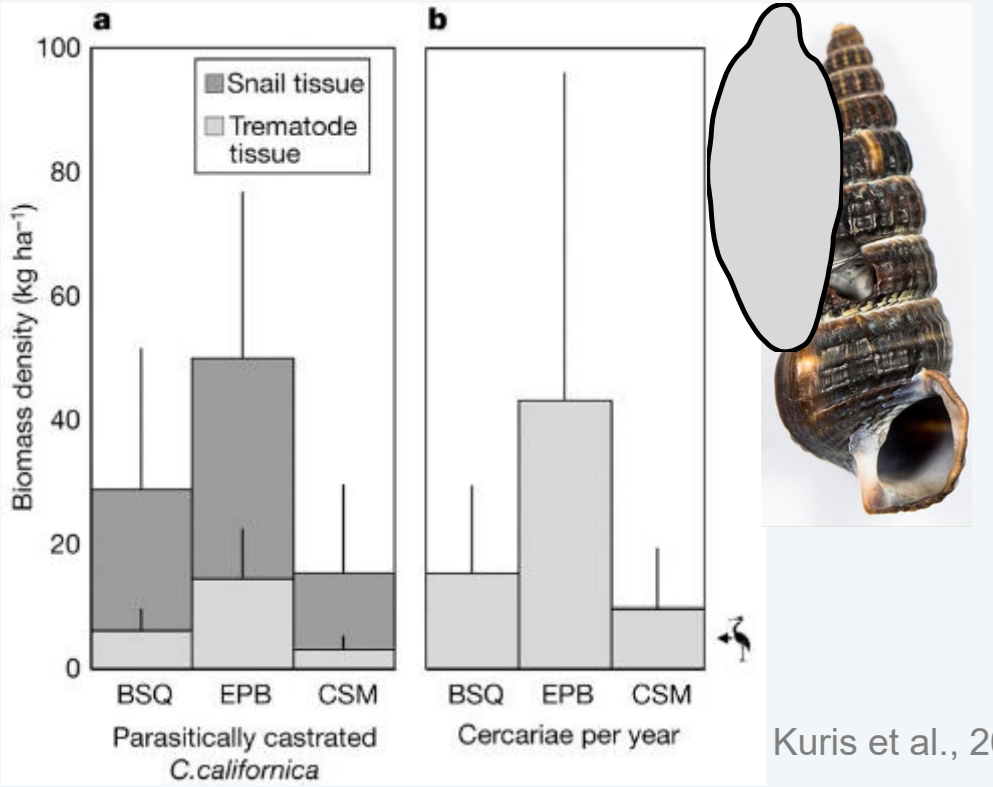
Lake Victoria's fish parasites: a story of ecosystem transformation

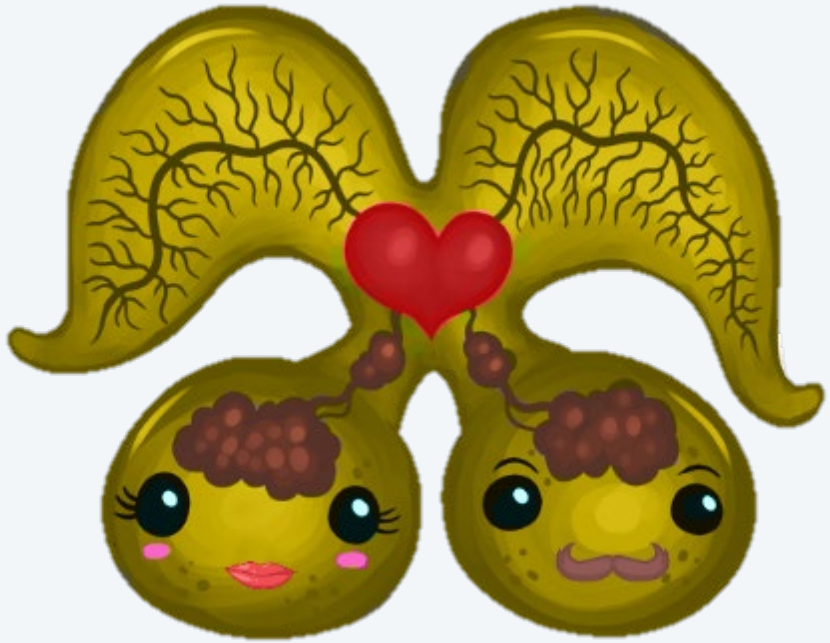
Joint Parasitology Spring Meeting
Würzburg, 11-14 March 2025

Parasites & Ecosystems

Wildlife parasites are fascinating and… important for ecosystems!

Substantial part of the biomass





Kuris et al., 2008

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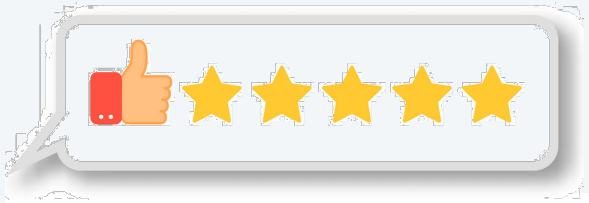
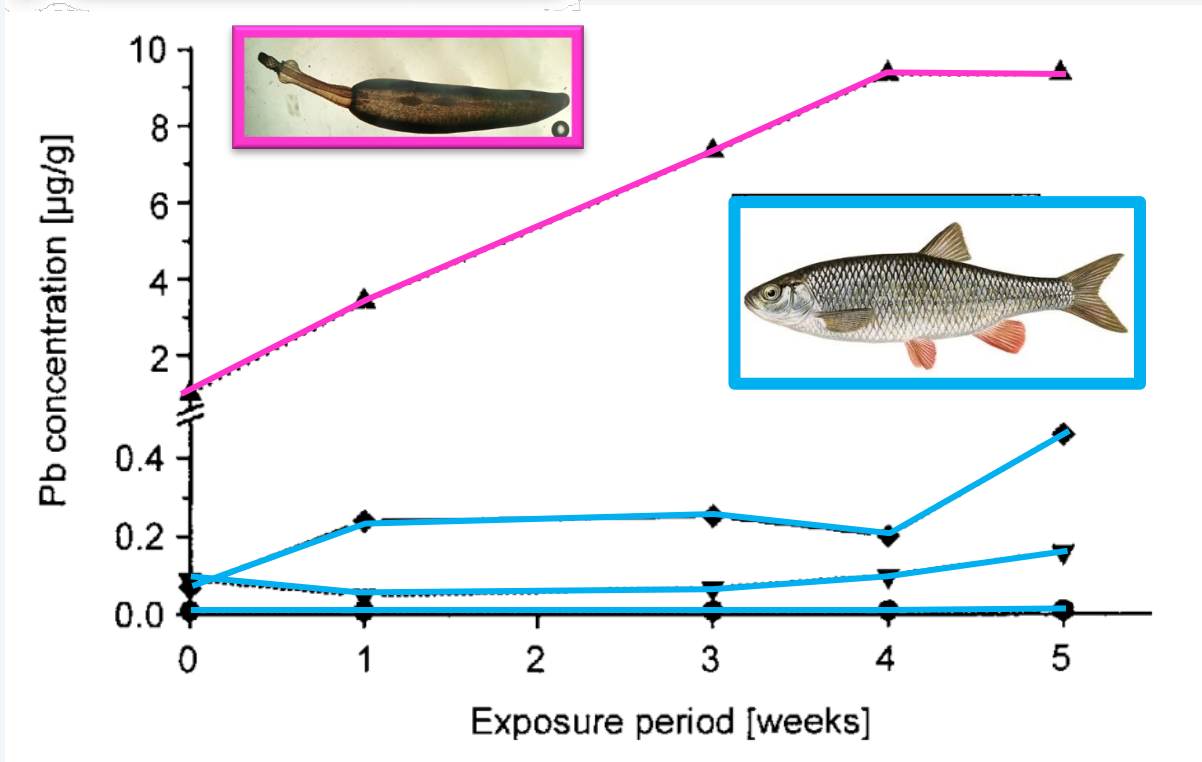


Sures & Siddal, 2003



Parasites & Ecosystems

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Lafferty et al., 2006

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Provide many ecosystem services:

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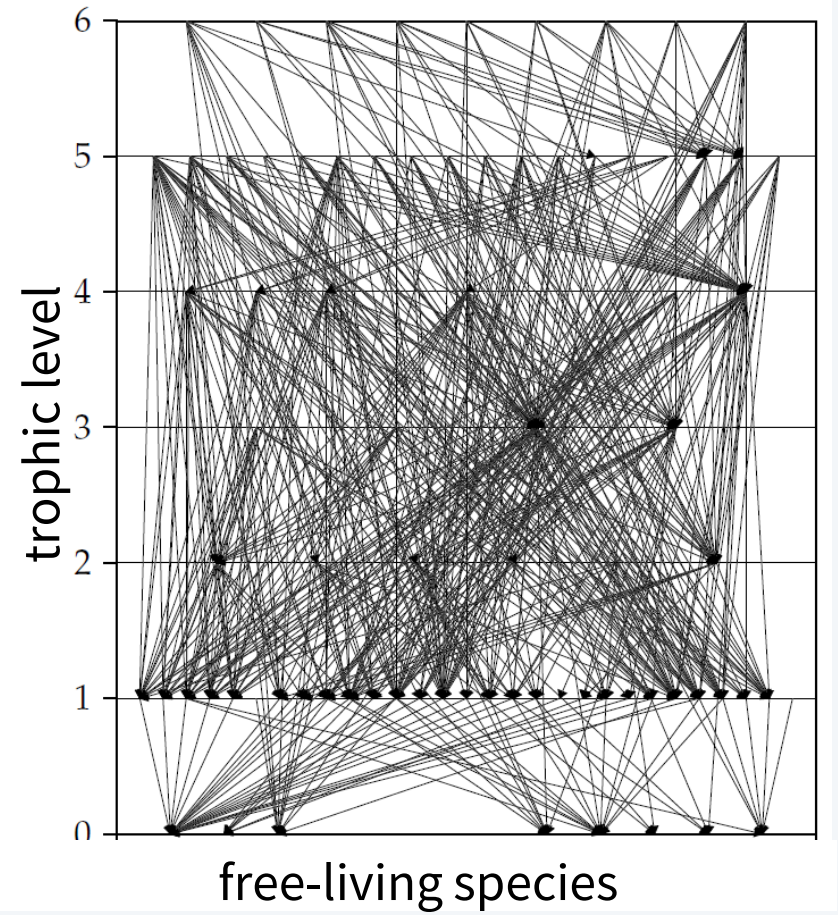
- Linking food webs
  (75% of the links)



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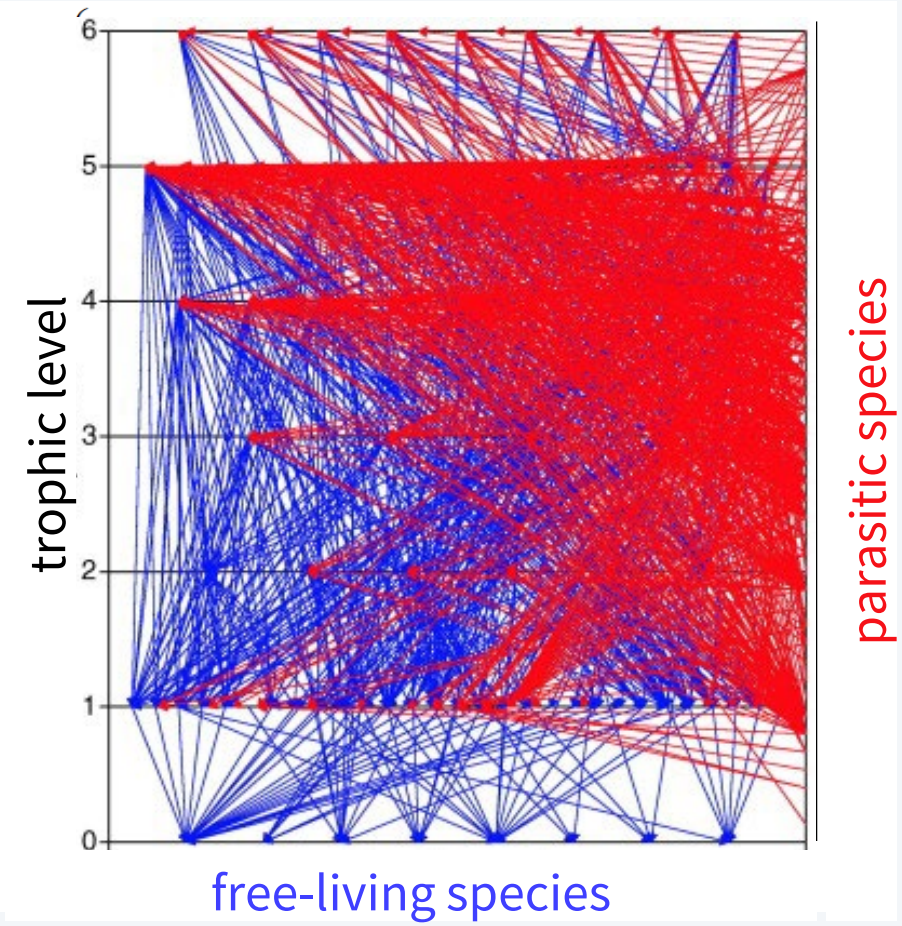
Lafferty et al., 2006



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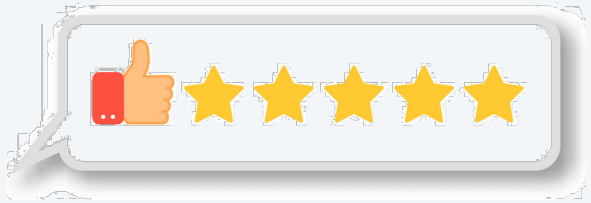

Provide many ecosystem services:

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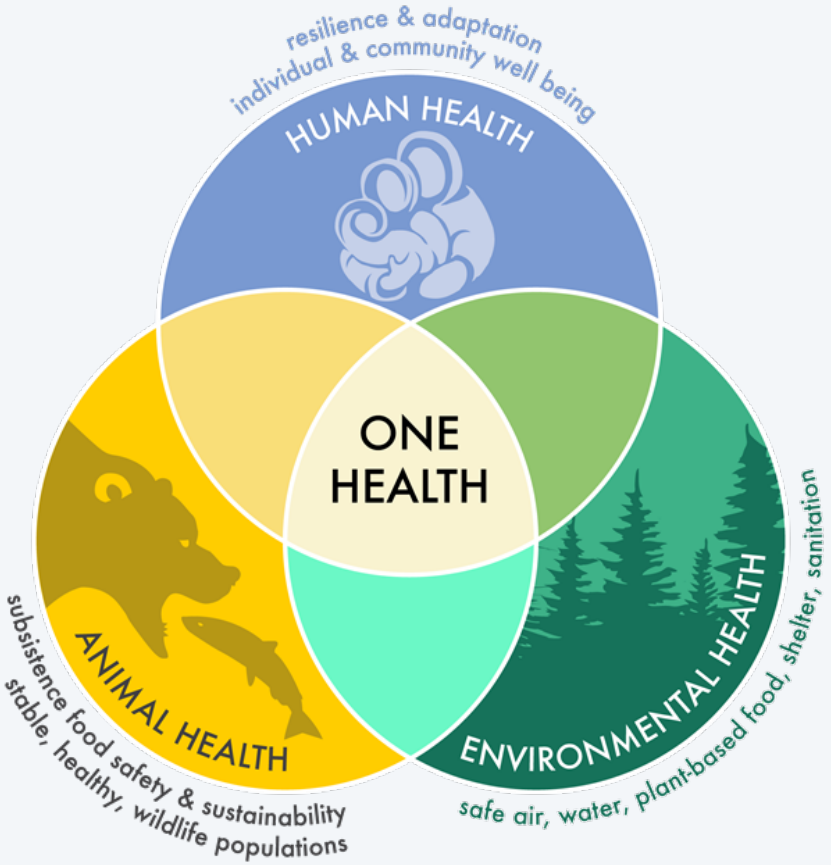
- Linking food webs
  (75% of the links)

Wildlife parasites contribute to ecosystem robustness and resilience

Parasites & Ecosystems



What can we learn from wildlife parasites?

- **Status of ecosystem health**
  An ecosystem rich in parasites is a 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)

One Health

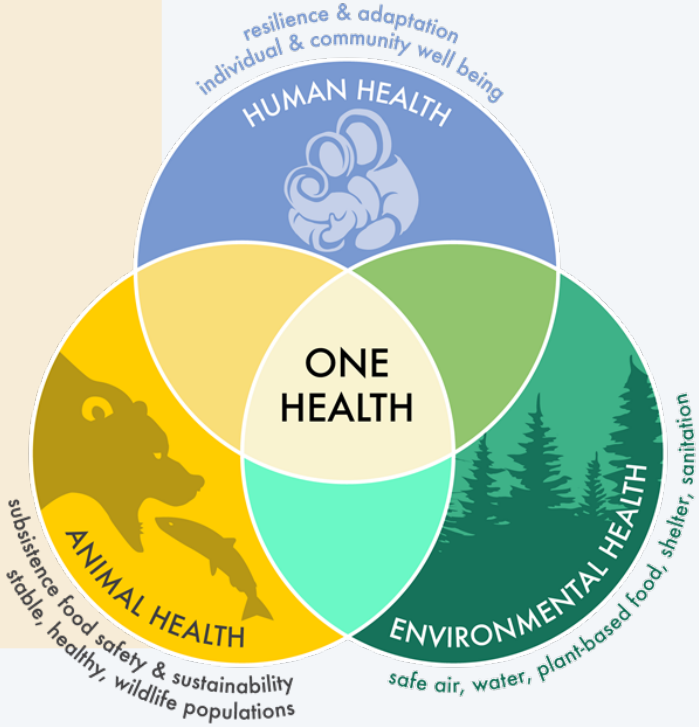
“us versus them”

Animals as potential threat

rabies risk from raccoons,
wildlife reservoirs of pathogens

Barrier approach

quarantine, avoidance behaviours,
vector/reservoir population control



Rabinowitz et al., 2008

One Health

“us versus them”

Animals as potential threat

rabies risk from raccoons,
wildlife reservoirs of pathogens

Barrier approach

quarantine, avoidance behaviours,
vector/reservoir population control

change in perspective

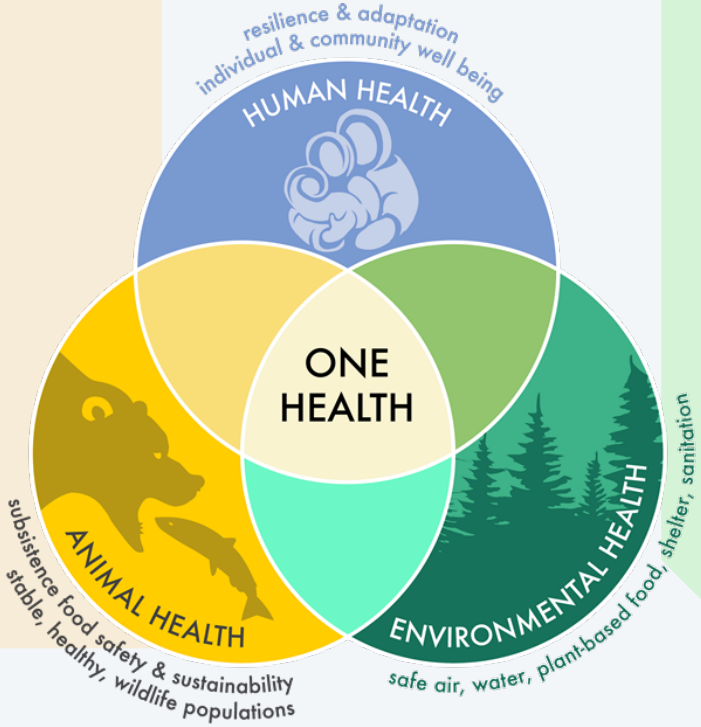
“shared risk”

Animals as sentinels

including wildlife parasites!

Dancing cats provided early warning
on methyl-mercury pollution

Human–animal–environment disease relationships



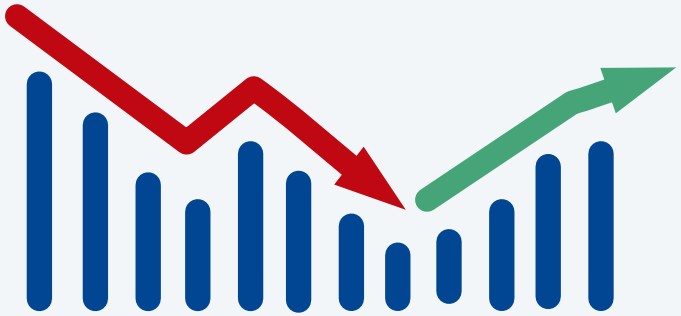
Rabinowitz et al., 2008

Parasites & Ecosystems

This is particularly relevant in the context of global change:

How global change affects parasites?

- Are wildlife parasites declining?
- If so, can we mitigate this?



Lake Victoria

Lake Victoria

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

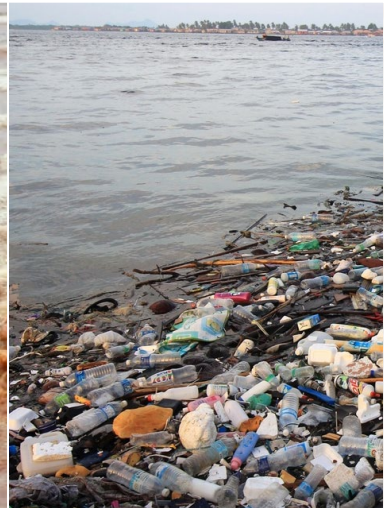
  human perturbations since 1980s

Lake Victoria

Anthropogenic changes

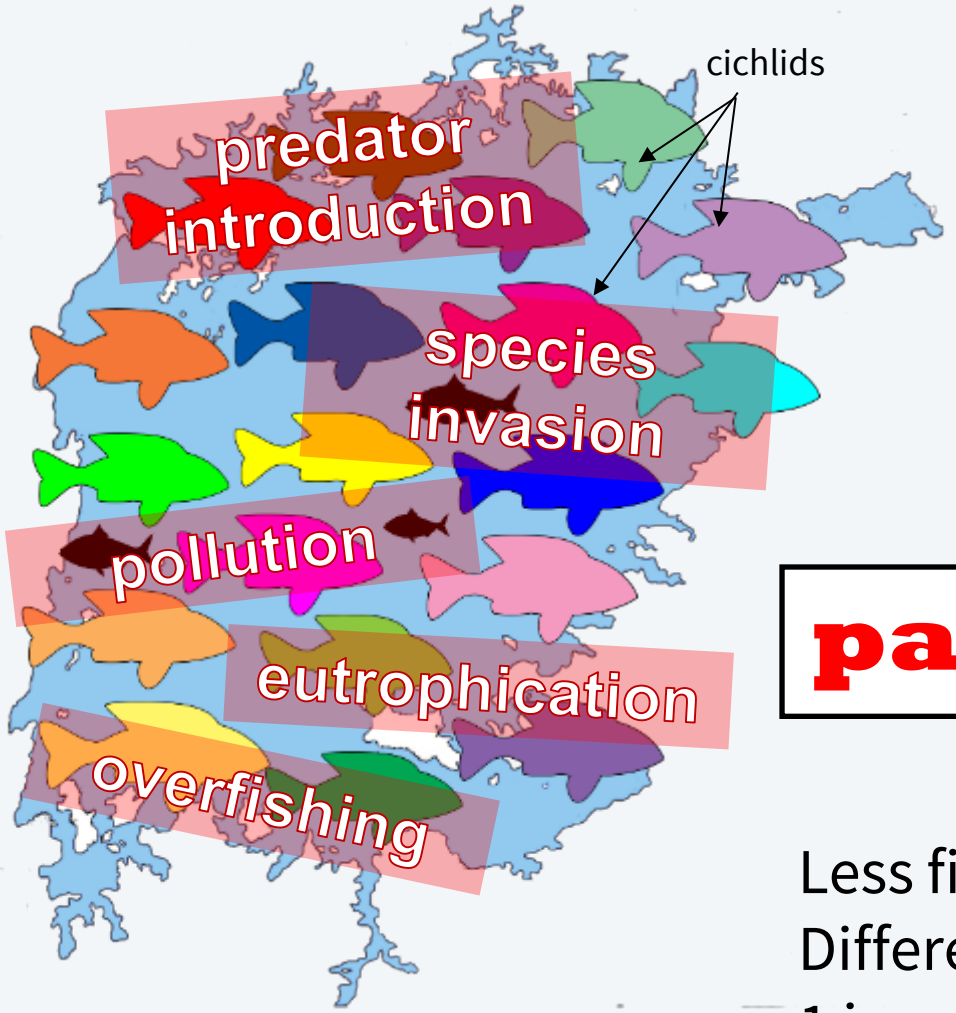
- Water eutrophication
- Species invasions
- Overfishing
- Pollution

Nile perch
(*Lates niloticus*)

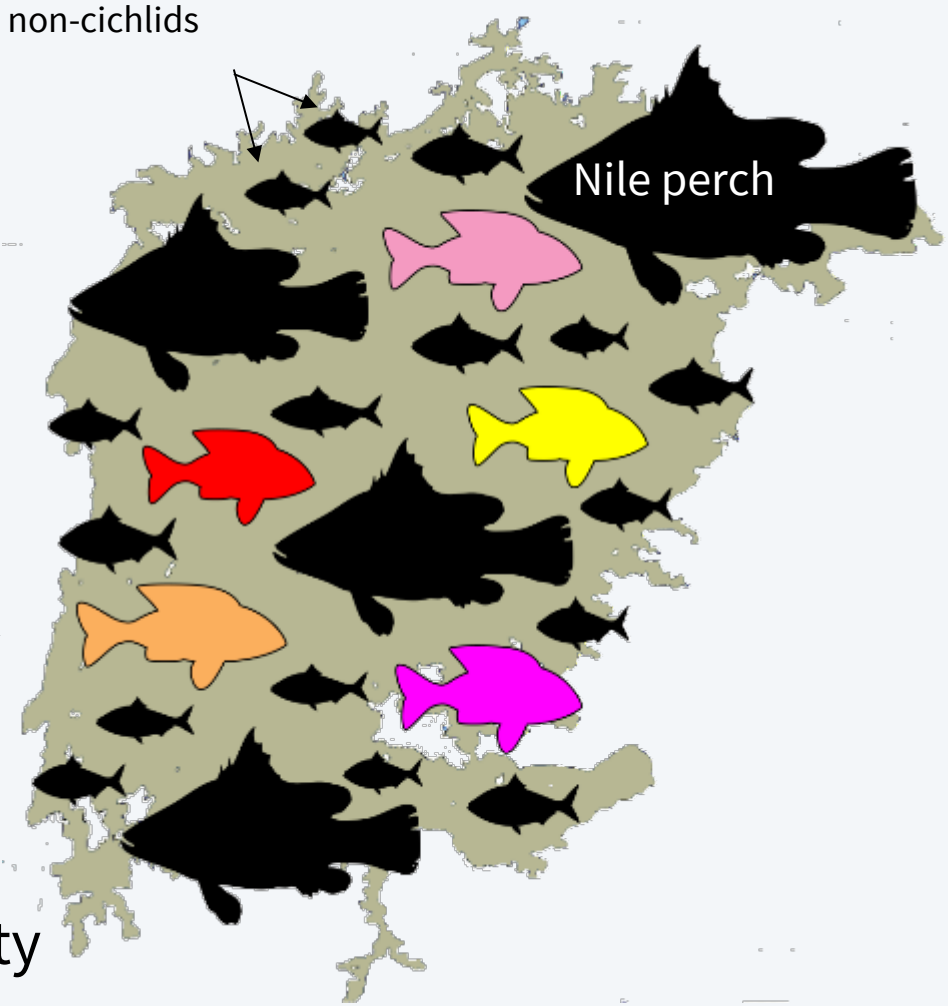


IISD – Experimental Lakes Area ELA

Lake Victoria

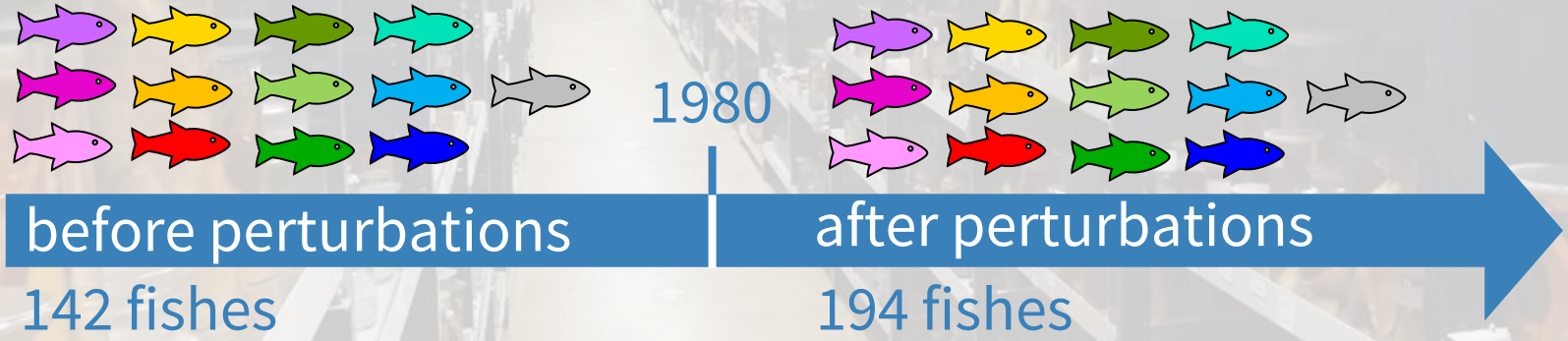


parasites?



Less fish species
Different fish community
1 invasive predator

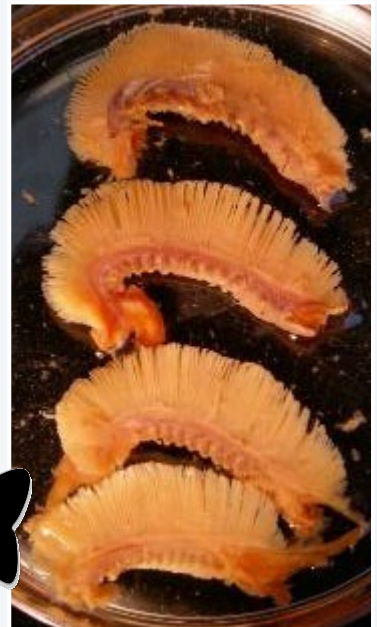
Lake Victoria: Study design



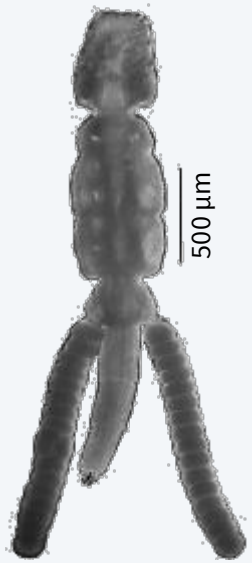
1 host individual = 1 parasite community

Before-after impact study, using historical and recent collections

13 cichlid fish species screened for gill macroparasites



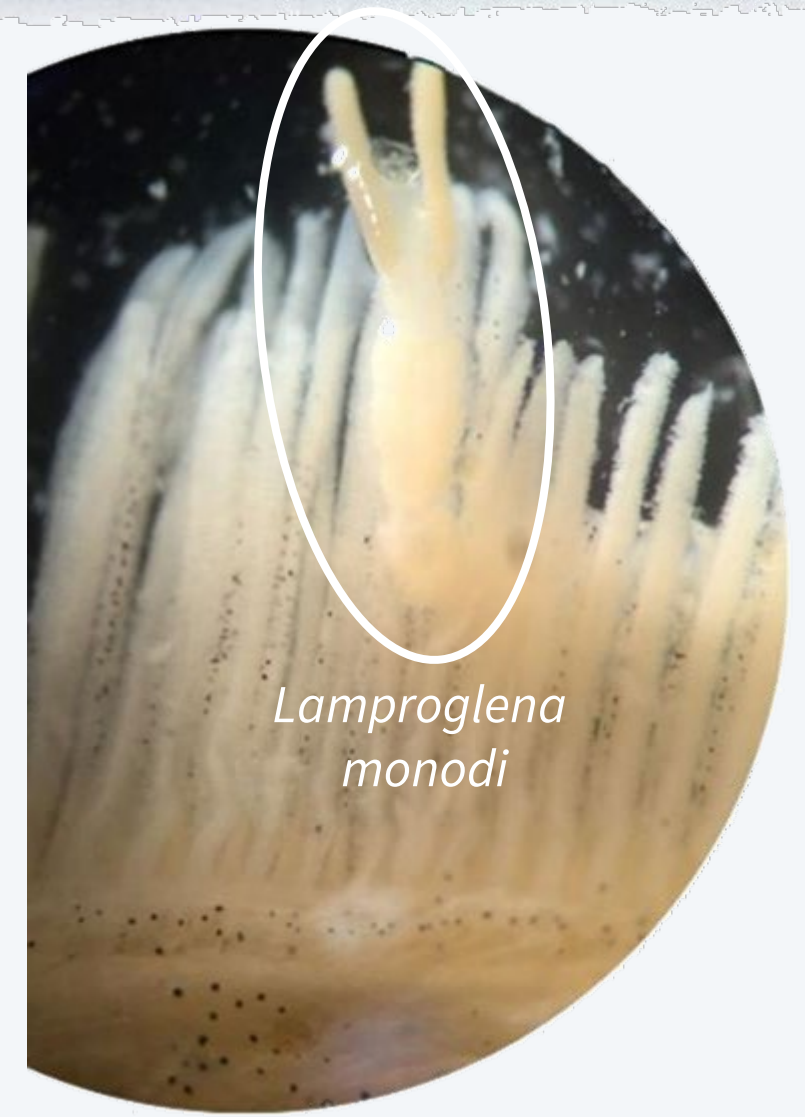
Lake Victoria: Gill parasites



Lamproglena monodi

Ergasilus lamellifer

copepods (crustaceans)



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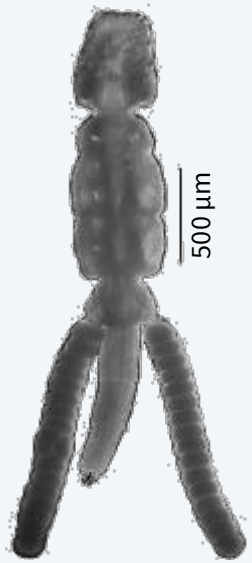


Lamproglena monodi

Ergasilus lamellifer

copepods (crustaceans)

C. nyanza

C. pseudodossoui

C. furu

C. vetusmolendarius

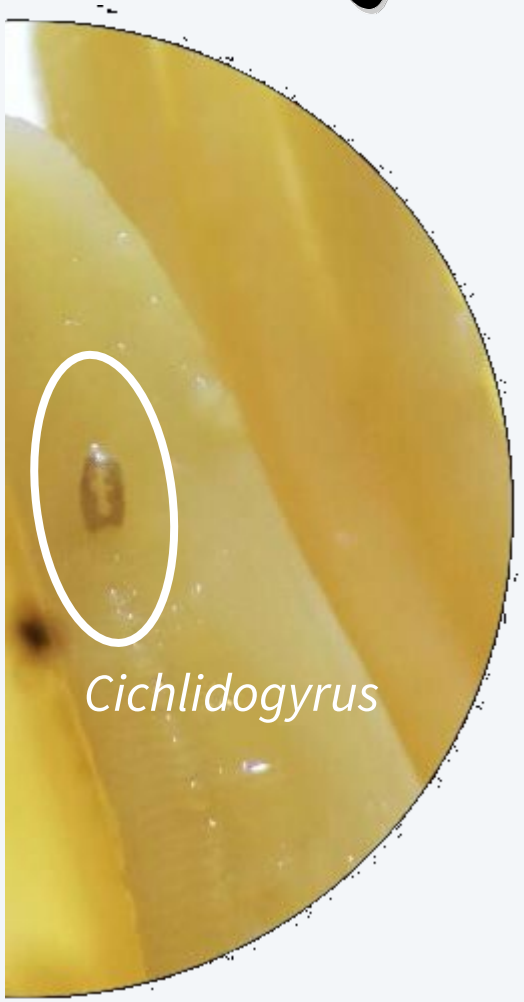
C. longipenis

C. bifurcatus

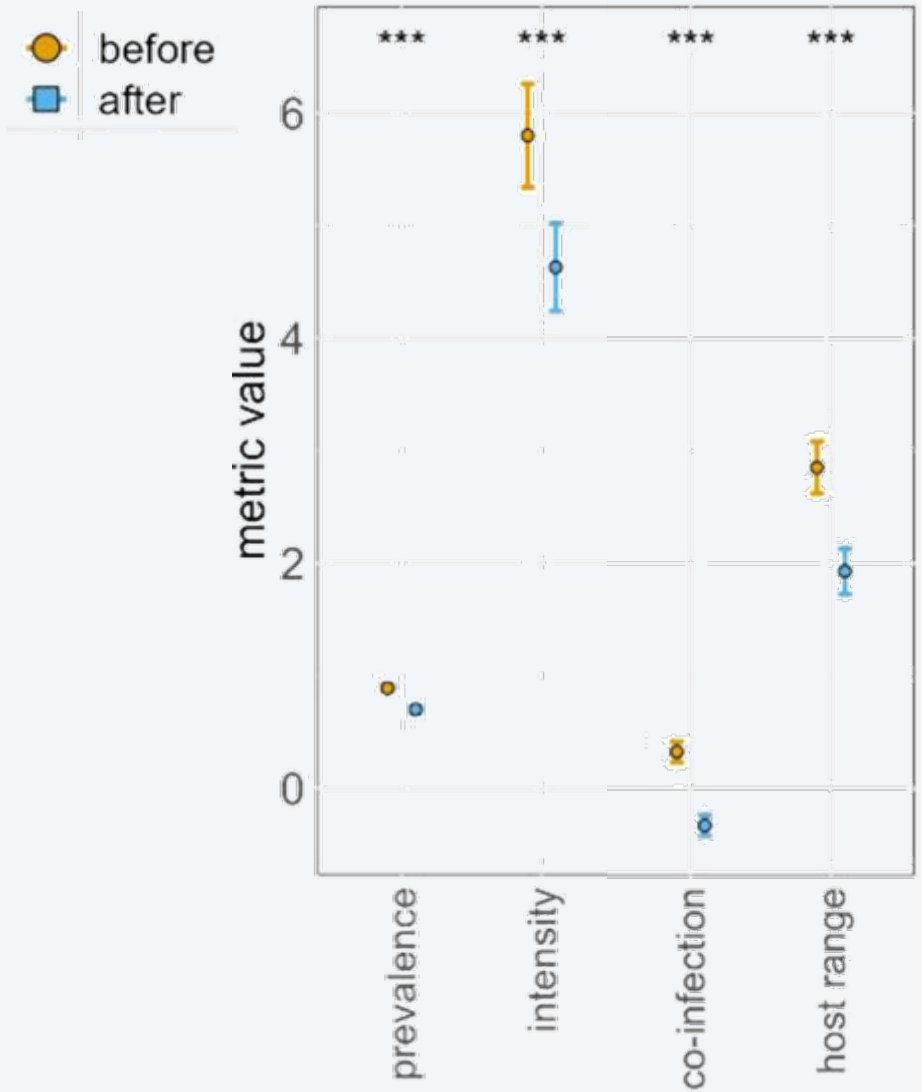
Cichlidogyrus

Gyrodactylus sturmbaueri

monopisthocotylans (flatworms)



Lake Victoria: temporal changes



Hurdle model, GLM

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)
- Parasite species infected **different** host species
  (result not shown here)

Disentangling the causes

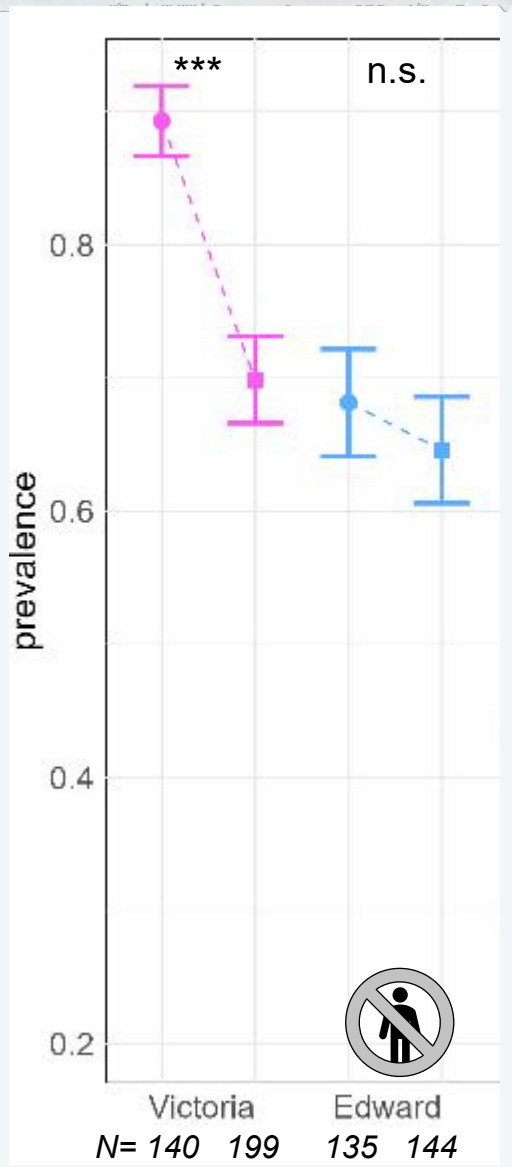
Are these changes in parasite infections really due to human perturbations?

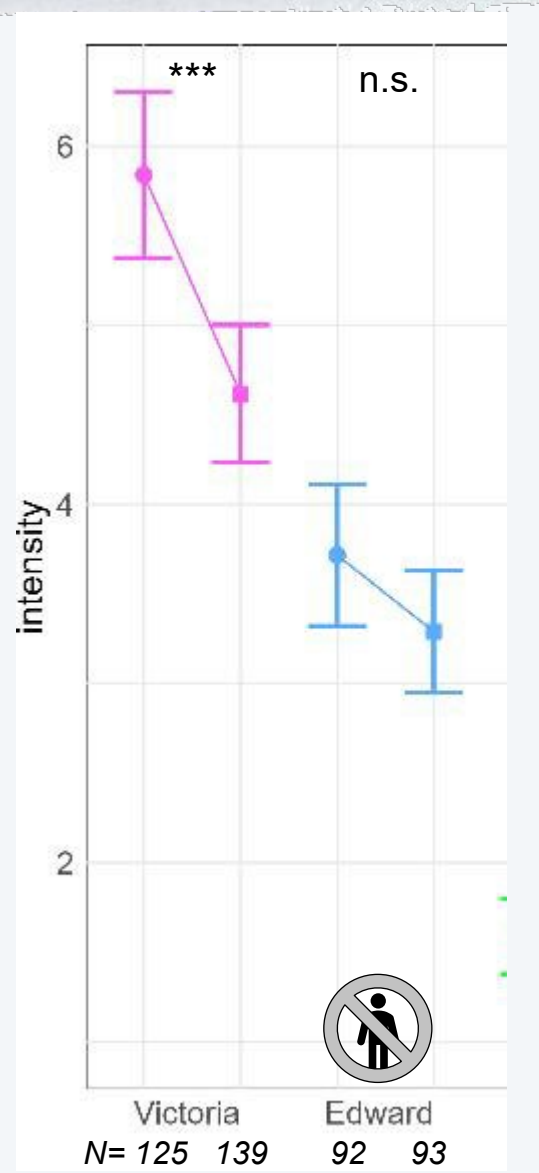
Lake Edward

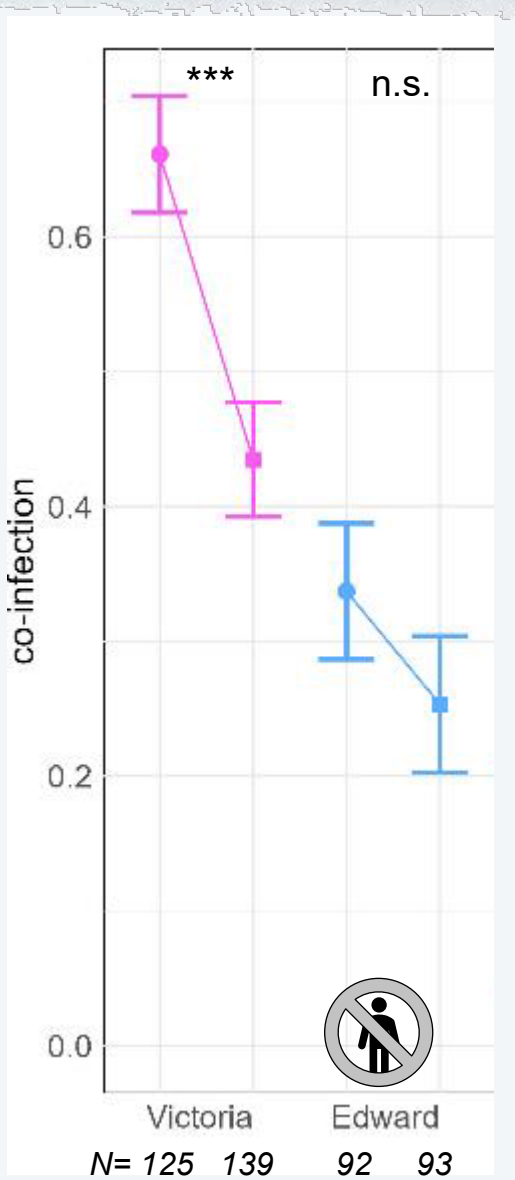
- (almost) pristine ecosystem
- Close to Victoria
- Harbouring cichlids from the LVictoria radiation superflock

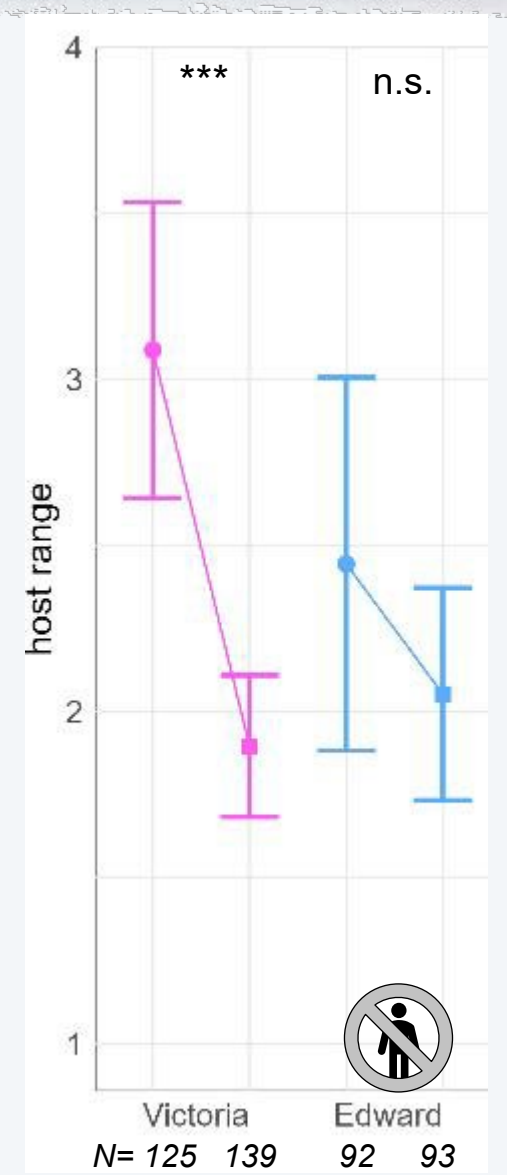
→ Test for temporal changes in parasitism in Lake Edward

Disentangling the causes









Lake Edward: unchanged

→ changes in parasitism in Lake Victoria 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

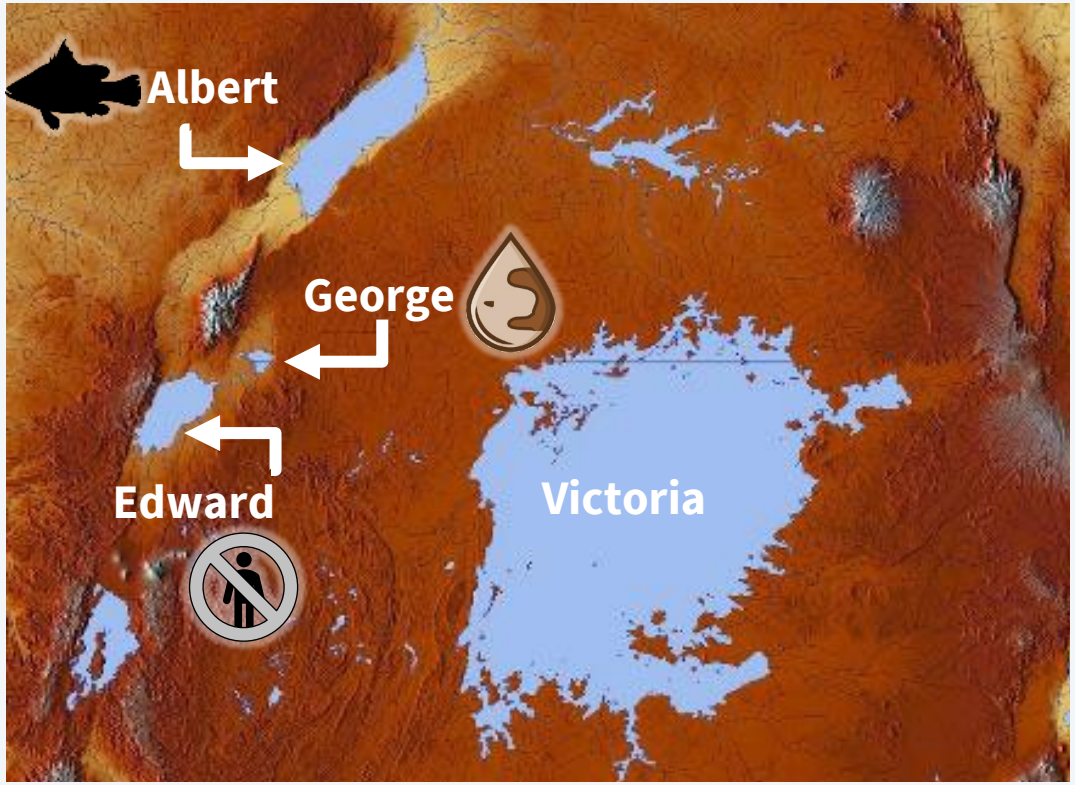
- Naturally high predation

Lake George

- Naturally eutrophic

- Close to Victoria
- Harbouring cichlids from the LVictoria radiation superflock

→ **space-for-time approach**



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

Parasites as sentinels:

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

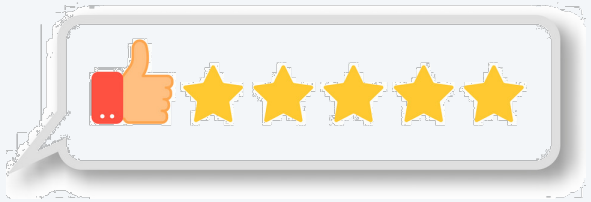
→ **Need to monitor changes in abundance:**

Are wildlife parasites threatened by extinction?

Conservation of wildlife parasites

Extinction of wildlife parasite species is not good news!

Wildlife parasites



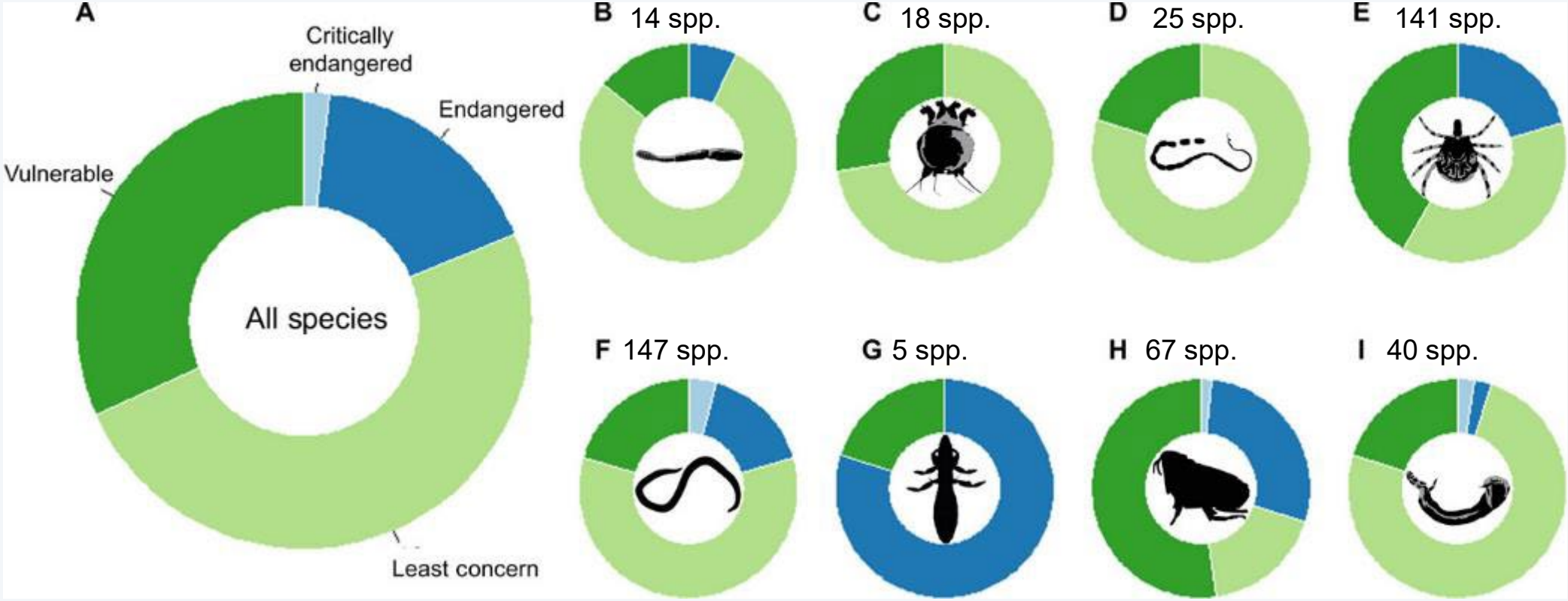
- Provide many ecosystem services
  regulating host populations
  linking food webs
  reducing impact of toxic pollutants
  contributing to biodiversity

- Have an intrinsic value
  are part of genetic and species diversity
  represent a (large) portion of evolutionary history

Conservation of wildlife parasites

Wildlife parasites are probably more endangered than their hosts

Carlson et al., 2017



Estimations based on habitat loss

Conservation of wildlife parasites

IUCN = International Union for Conservation of Nature

IUCN Parasite Specialist Group

Red List to assess conservation status of species
(parasites are across many taxon groups)

Raise awareness, contribute to action plans

<u>Wildlife parasites</u>:
Excluding parasites of humans and of domestic animals !

IUCN SSC PARASITE Specialist Group

Conservation

Commonly, (species-specific) parasites are intentionally removed during conservation actions targeting their hosts

Gophertortoise tick
(*Amblyomma tuberculatum*)

Gopher tortoise
(*Gopherus polyphemus*)

Amblyomma personatum
Dermacentor rhinocerinus

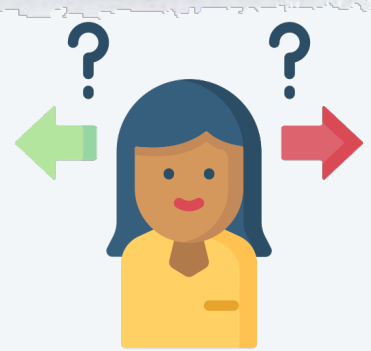
Black rhinoceros
(*Diceros bicornis*)

California condor louse
(*Colpocephalum californici*)

Californian condor
(*Gymnogyps californianus*)

→ increases the extinction risk of parasites
→ conservation-induced extinction

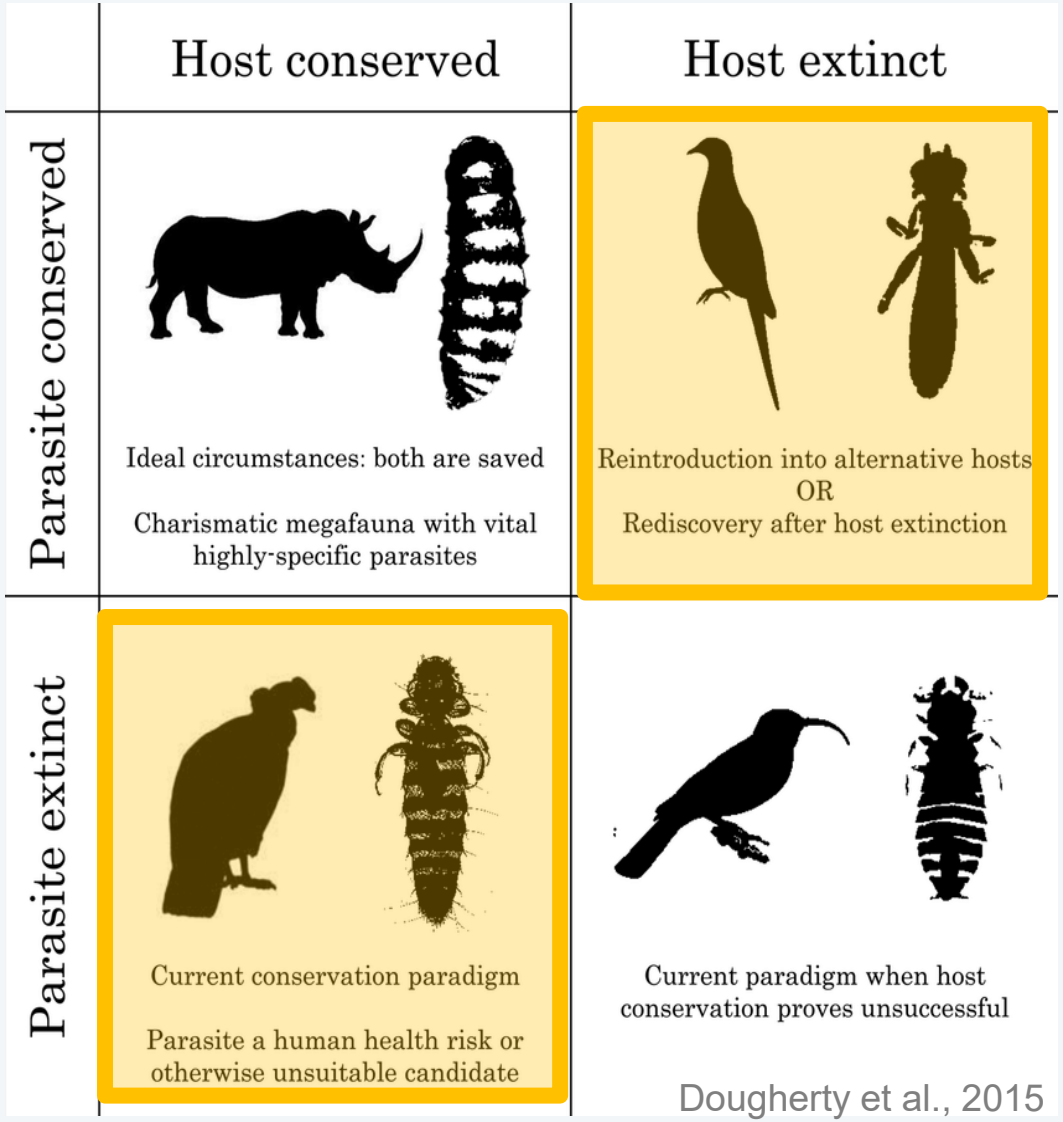
Dilemma of conserving parasites



Protect endangered free-living species at the risk of causing parasite decline/extinction?

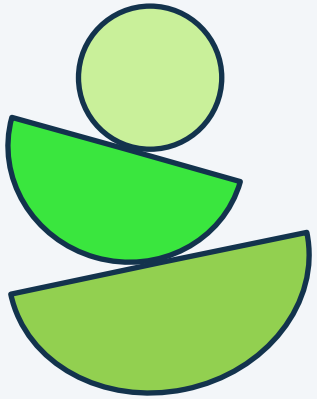
OR

Protect endangered parasite species at the risk of decreasing host fitness?

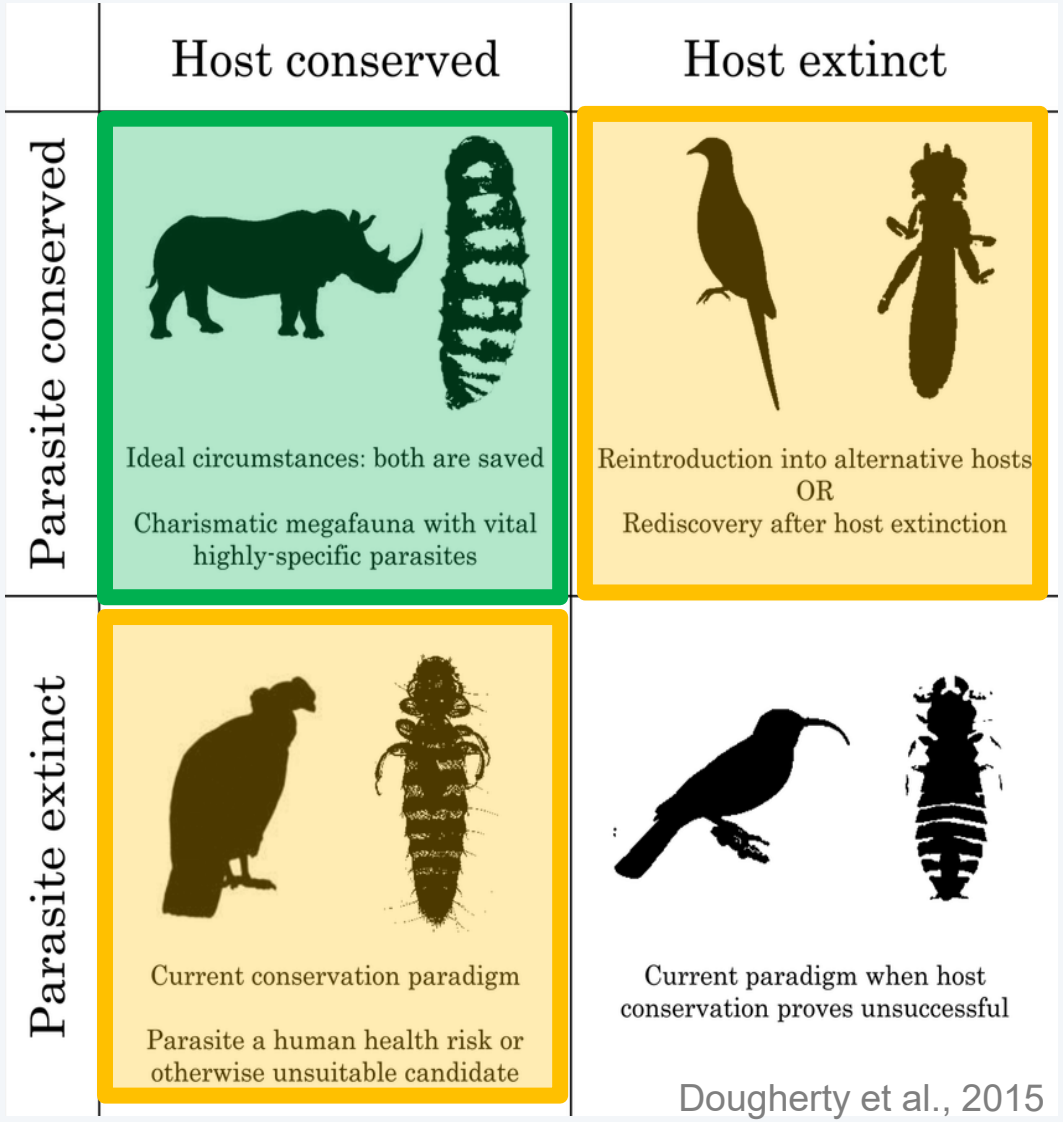


Dougherty et al., 2015

Dilemma of conserving parasites



Conservation of one species
should NOT hamper
the conservation of other species!

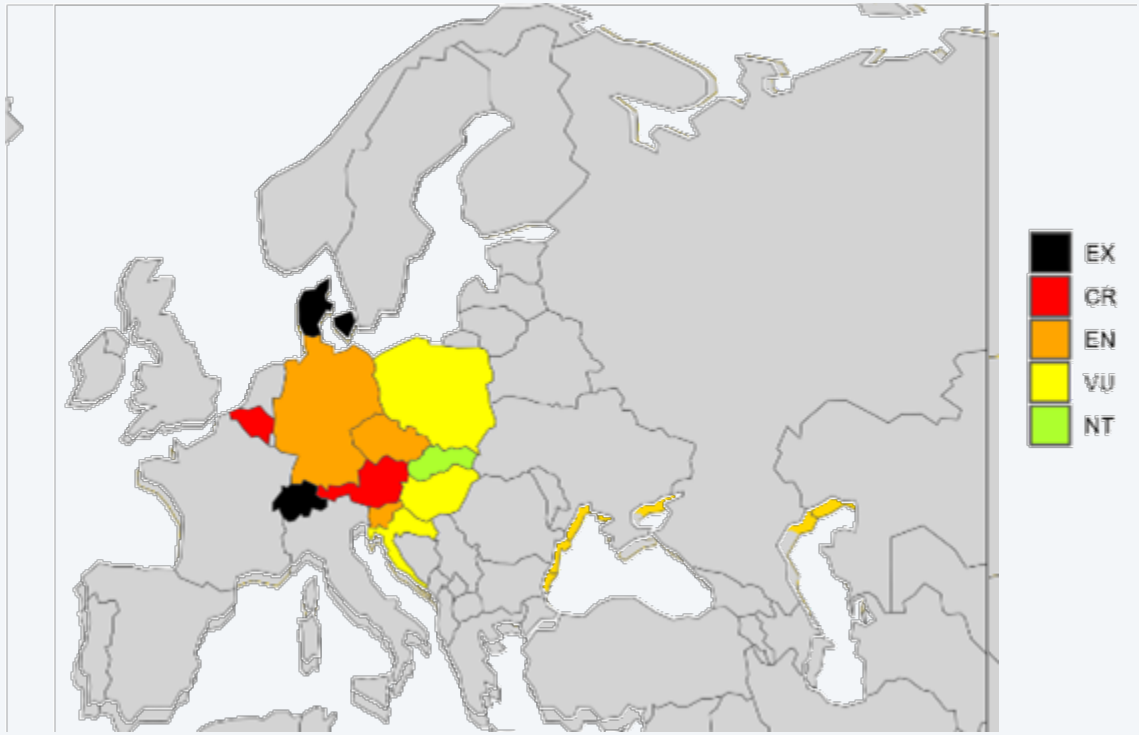


Dougherty et al., 2015

European weatherfish

European weatherfish (*Misgurnus fossilis*)

Decreased in large parts of its native range → endangered
(habitat loss, pollution, invasion of two Asian congeners)

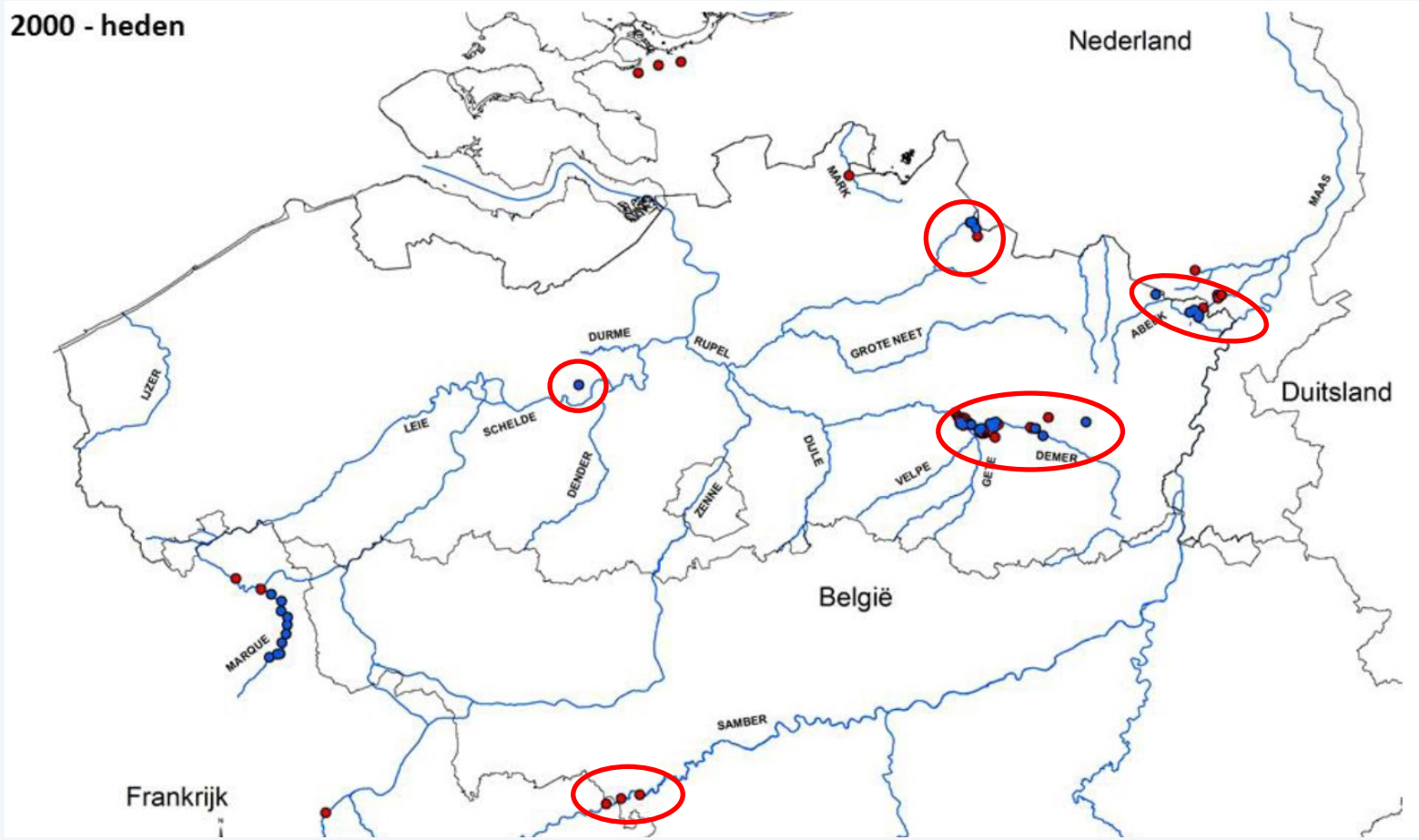


European weatherfish

Belgium: critically endangered (few small populations left)

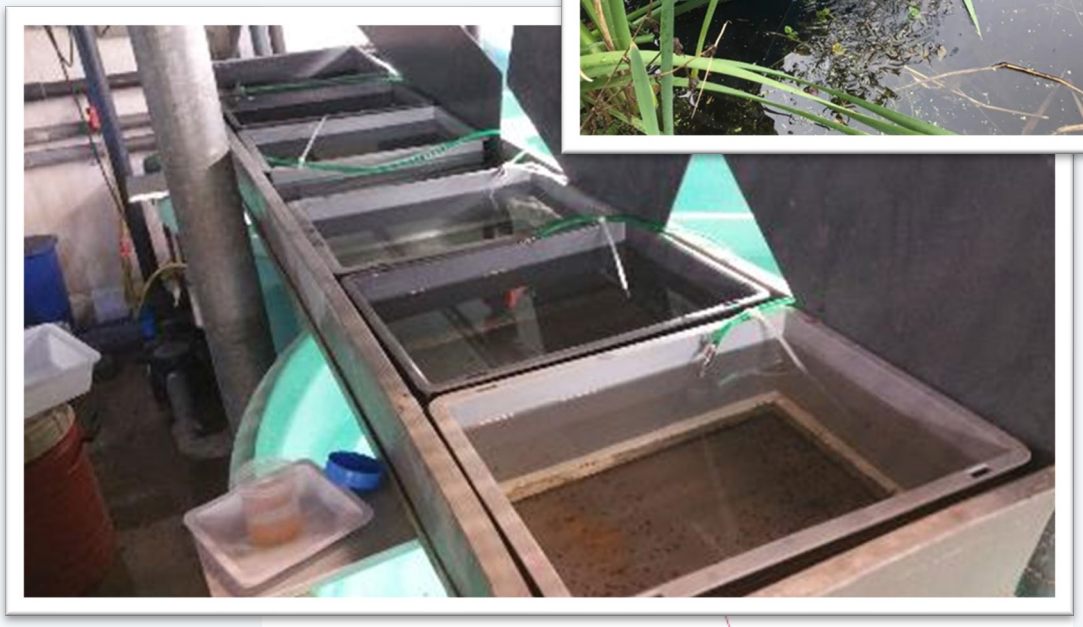
CR

Critically Endangered



European weatherfish

Belgium: critically endangered (few small populations left)
Since 2021: protection plan in Flanders



Ex-situ breeding

- to restock existing Flemish populations
- to establish new ones in suitable habitats

INSTITUUT NATUUR- EN BOSONDERZOEK

Vlaanderen is wetenschap

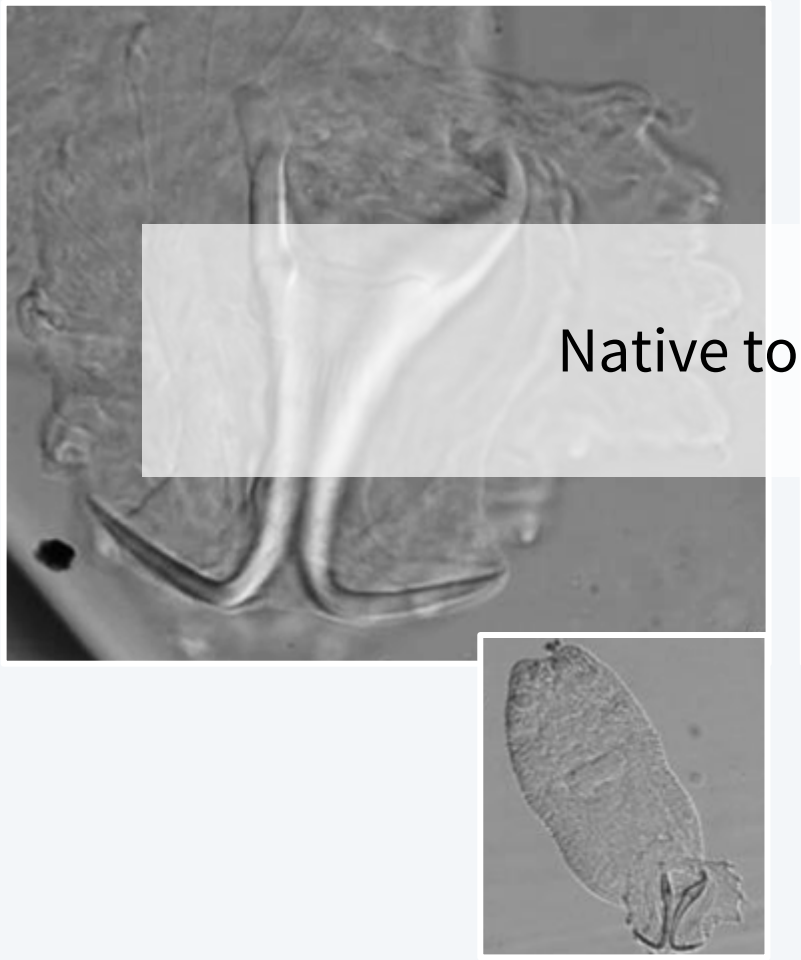
Parasites of the European weatherfish

What about their parasites?

18 fish from 2024 (9 adults + 9 juveniles)
9 fish from 1881-1973 (9 adults)

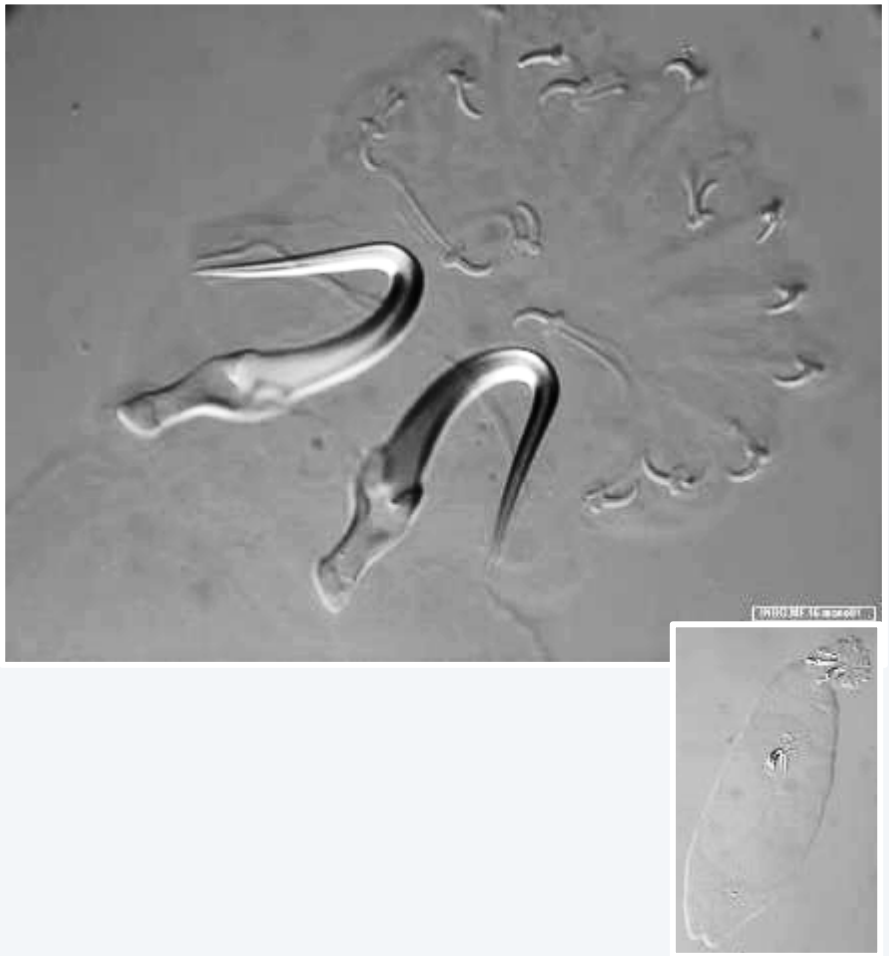
Parasites of the European weatherfish

Gyrodactylus misgurni
(Gyrodactylidea)



Actinocleidus cruciatus
(Dactylogyridea)

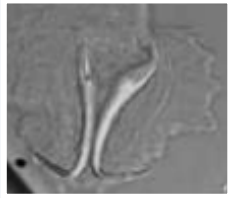
Gyrodactylus fossilis
(Gyrodactylidea)



Native to Belgium

Parasites of the European weatherfish

(unofficial) extinction risk in Czech Republic & Slovakia



HELMINTH CLASS/IUCN CATEGORY Helminth species	Host species	River basin[1]	Proposed IUCN category for Czech / Slovak Rep.[2]
MONOGENEA/CRITICAL			
Ancyrocephalus cruciatus (Wedl, 1857)	*M. fossilis*	E. O. D	EN / CR
Dactylogyrus chondrostomi Malevitskaja, 1941[3]	*C. nasus*	D	CR / SU
Dactylogyrus dirigerus Gusev, 1966	*C. nasus*	D	CR / SU
Dactylogyrus ergensi Molnár, 1964	*C. nasus*	D	CR / SU
Dactylogyrus nybelini Markevitch, 1933[3]	*C. nasus*	D	CR / SU
Dactylogyrus simplicimalleata Bychowsky, 1961[3]	*P. cultratus*	D	CR / VU
Gyrodactylus fossilis Lupu et Roman, 1956	*M. fossilis*	E. O. D	EN / CR
Gyrodactylus macrocornis Ergens, 1963	*C. nasus*	D	CR / SU
Gyrodactylus misgurni, Ling Mo-en 1962	*M. fossilis*	D	helminth not recorded / CR
Gyrodactylus paraminimus Ergens, 1966	*C. nasus*	D	CR / SU
Paradiplozoon vojteki (Pejčoch, 1968)	*P. cultratus*	D	CR / VU

CR

Critically Endangered

EN

Endangered

Baruš et al., 1997

Winning pair

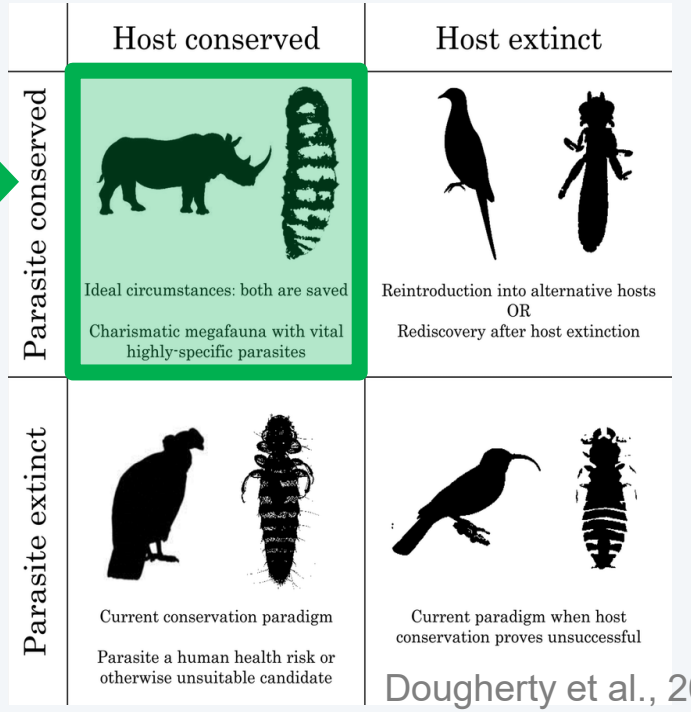
Normally, under moderate abundance, flatworms do not kill their hosts (instead: breeding populations)

→ not necessary to actively remove them during host conservation actions

Without parasite removal, conservation actions for hosts can benefit parasites, too!

→ Integrate parasitological assessments into conservation good practices

→ Collaborate with (host) conservation experts



Dougherty et al., 2015

Parasite perception

You protect what you like, and you like what you understand

→ Raise awareness on the importance of wildlife parasites

To better communicate with the public, we need to know

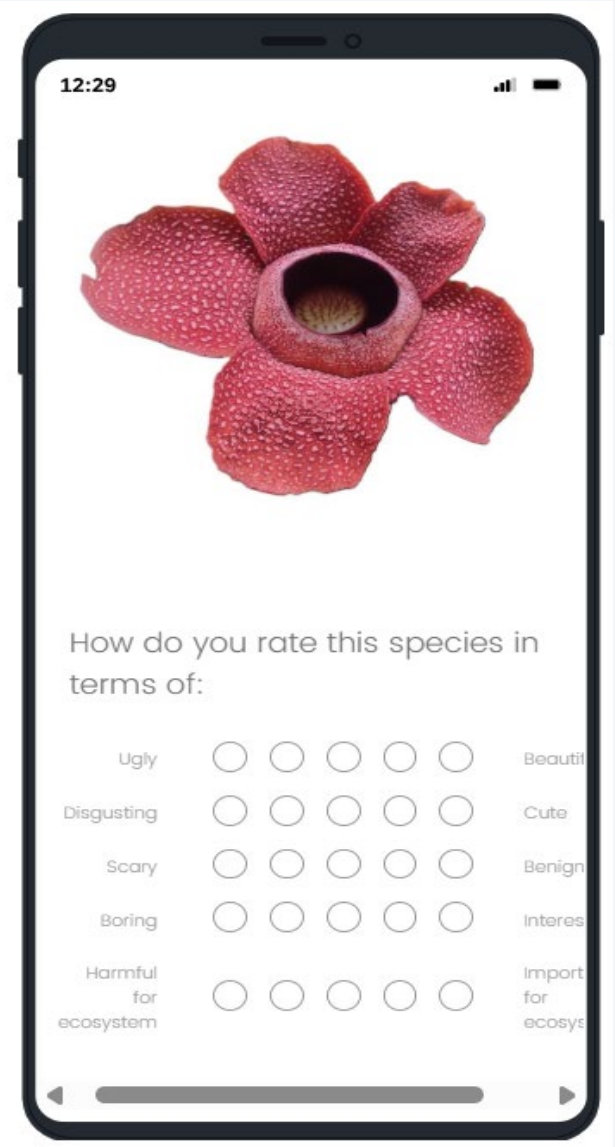
- what people **like** about wildlife parasites
  → **take advantage of this**
- what people **don't like** about wildlife parasites
  → **work to change this**

Parasite perception

WASP-P

World **A**rchives of **S**pecies **P**erception of **P**arasites

https://tinyurl.com/wasp-parasite



Swiss National Science Foundation

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IUCN SSC PARASITE Specialist Group

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natural sciences .be

Thank you

Aquatic Biodiversity lab @ 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)

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Parasite perception

https://tinyurl.com/wasp-parasite

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- Hasik AZ., Ilvonen JJ, **Gobbin TP**, Suhonen J, Beaulieu JM, Poulin R, Siepielski AM (subm.) **Biodiversity through the lens of parasitism – how parasitism drives host diversification**. Under review: *Nature Reviews Biodiversity*

- **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). 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-c[illegible] and laboratory-bred cichlid fish, and their hybrids, implicate extrinsic rather than intrinsic causes of speci[illegible] differences in infection**, *Hydrobiologia* 848(16), 3817-3831. doi:10.1007/s10750-020-04423-7.