Hacking Limnology 2024

4th joint Virtual Summit and Workshops

15-17th July AEMON-J Workshop
18-19th July DSOS Summit

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Insights from global data collection on freshwater zooplankton body size

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(1) Pôle R&D ECLA, OFB, (2) Universitat de Barcelona, (3) BETA Technological Center (UVic-UCC), … (see next slide for full affiliations)

ZooSize

GLEON
global lake ecological observatory network

project's page

From left to right, top to bottom: Lake Taal (PH) © Marjohn Baludo, LakePonjavica (RS), © Zorka Dulić, La Era (ES) © Mercedes López-Vázquez, Lake del Colastiné (AR), © María Florencia Gutierrez, Lake Anterne (FR) © Rosalie Bruel, Lucieńskie Lake (PL) © Dariuzs Halabowski, Lake Most (CZ), © Maria Anton

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All 80 authors are involved in meetings and conceptualisation

aA **Taxa names harmonization**

Preservative survey

Map verifications

Current leads of the project

Zooplankton Workshop

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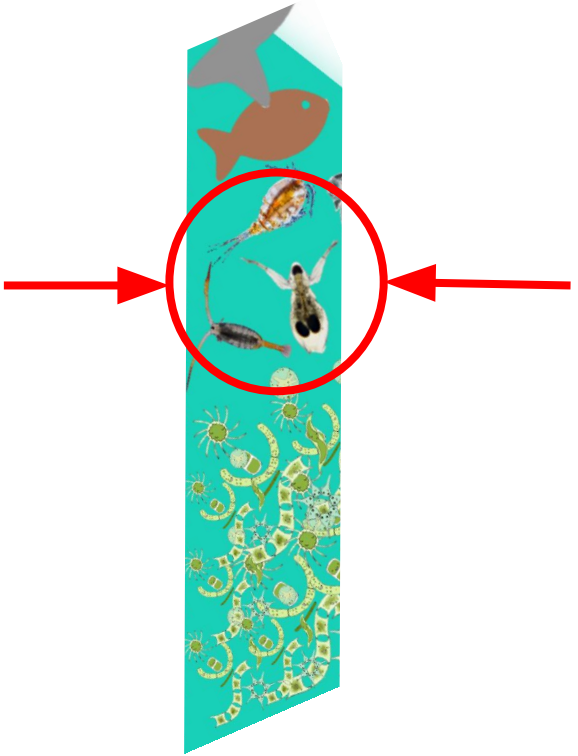
Why is zooplankton a potential good indicator of ecological state?

- Short generation times
- Intermediate position in food web
- Responsive to bottom-up and top-down stressors
- Abundance and body size easily measured



Why size?

Size is an **easily measured trait (measurement can be automated)**.

Pros:

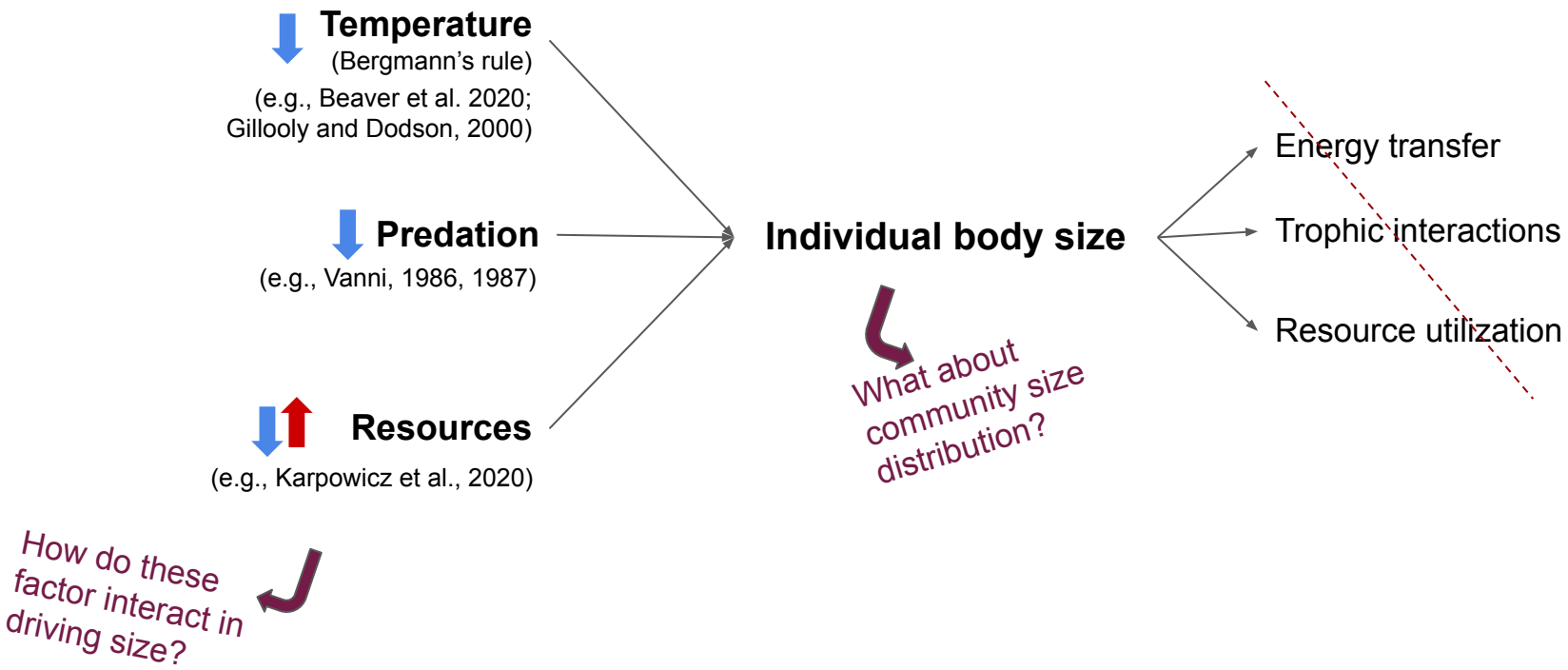
- integrative ecological concept,
- avoid taxonomic errors,
- effective way to link community structure to ecosystem functioning.

Reducing organisms to their size is an often **controversial viewpoint**, but there is knowledge to be gained by **reconciling size-based and taxonomy-based approaches** (Petchey and Belgrano, 2010).

Question:

How do size distributions of crustacean zooplankton communities differ across the globe and how are they influenced by bottom-up and top-down processes?

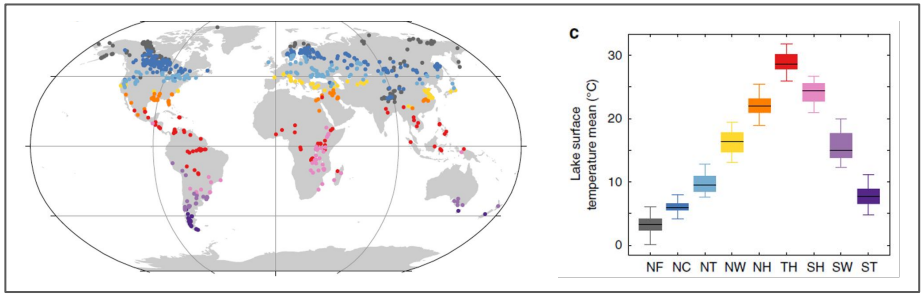
Framework of the study



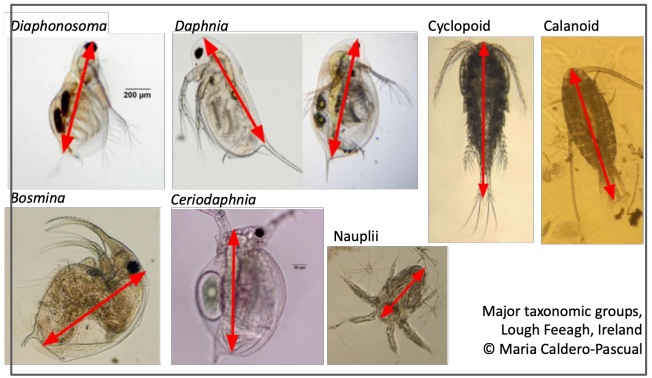
Hypothesis: temperature * resources * predation INTERACTIONS!

Previous studies…

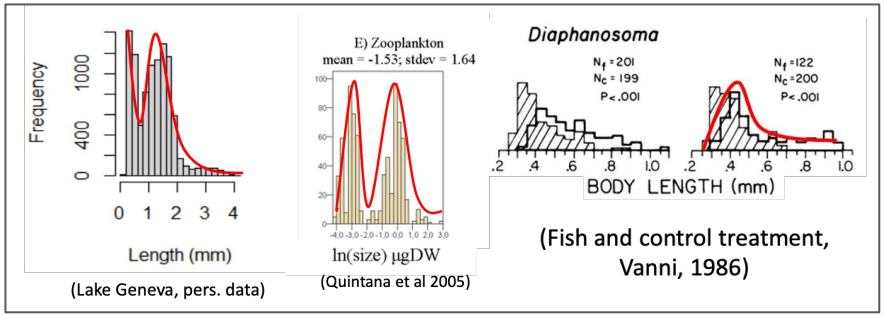
(1) either focussed on regions in the world or did not include other factors affecting size: **our objective was to have as close as a global coverage as possible** (thermal regions, Maberly et al 2020) **+ include multiple drivers**



(2) (often) focussed on Cladocera and/or strictly Daphnia: **we wanted to investigate size variation the whole crustacean zooplankton community**

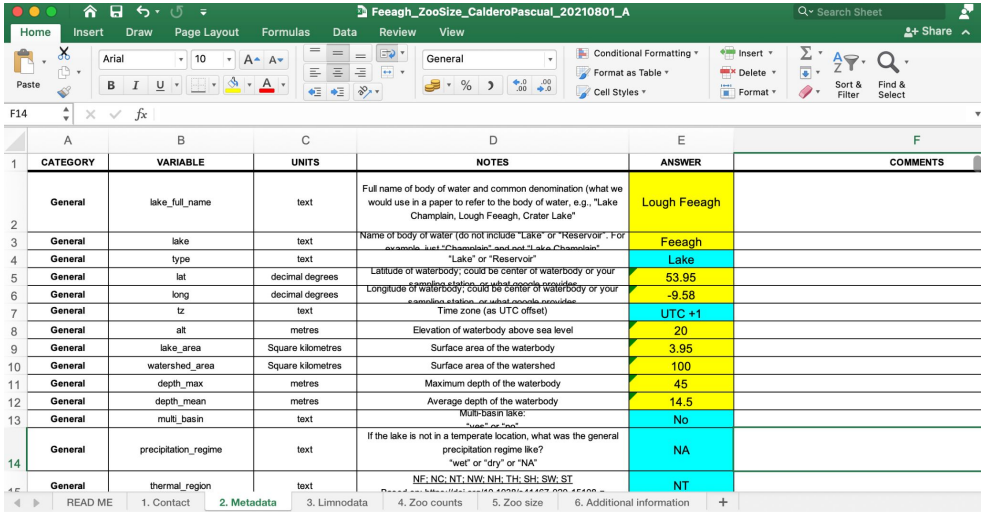


(3) focussed on mean size (but see Quintana et al. (2008) for example): **we wanted to test for multiple size metrics**



⇒ A new data call was required.

We asked for only ONE sampling event but extensive metadata to disentangle temperature, nutrients and (hopefully) predation effects.



	A	B	C	D	E	F
1	CATEGORY	VARIABLE	UNITS	NOTES	ANSWER	COMMENTS
2	General	lake_full_name	text	Full name of body of water and common denomination (what we would use in a paper to refer to the body of water, e.g., "Lake Champlain, Lough Feeagh, Crater Lake"	Lough Feeagh	
3	General	lake	text	Name of body of water (do not include "Lake" or "Reservoir". For example, just "Champlain" and not "Lake Champlain"	Feeagh	
4	General	type	text	"Lake" or "Reservoir"	Lake	
5	General	lat	decimal degrees	Latitude of waterbody; could be center of waterbody or your sampling station, or what google provides	53.95	
6	General	long	decimal degrees	Longitude of waterbody; could be center of waterbody or your sampling station, or what google provides	-9.58	
7	General	tz	text	Time zone (as UTC offset)	UTC +1	
8	General	alt	metres	Elevation of waterbody above sea level	20	
9	General	lake_area	Square kilometres	Surface area of the waterbody	3.95	
10	General	watershed_area	Square kilometres	Surface area of the watershed	100	
11	General	depth_max	metres	Maximum depth of the waterbody	45	
12	General	depth_mean	metres	Average depth of the waterbody	14.5	
13	General	multi_basin	text	Multi-basin lake: "yes" or "no"	No	
14	General	precipitation_regime	text	If the lake is not in a temperate location, what was the general precipitation regime like? "wet" or "dry" or "NA"	NA	
15	General	thermal_region	text	NF; NC; NT; NW; NH; TH; SH; SW; ST	NT	

Data template*

1. *Contact information*
2. **Metadata**: lake size, latitude, longitude, multi-bassins or not, sampling net and other method, etc.
3. **Limnodata**: dominant piscivore and planktivore, physico-chemical variables
4. **Zoo counts**: crustacean zooplankton ID and densities
5. **Zoo size**: individual size measurements for every taxa in tab 4.
6. *Additional information (willing to collaborate to future project, etc.)*

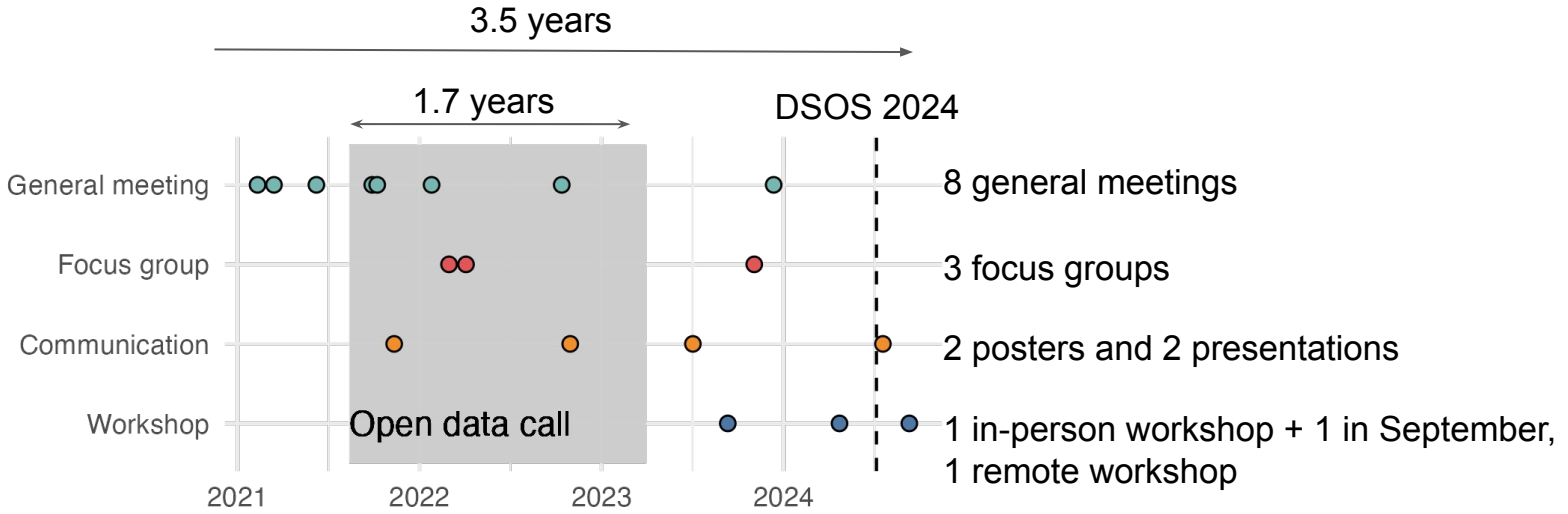
* MultiLakes data template available

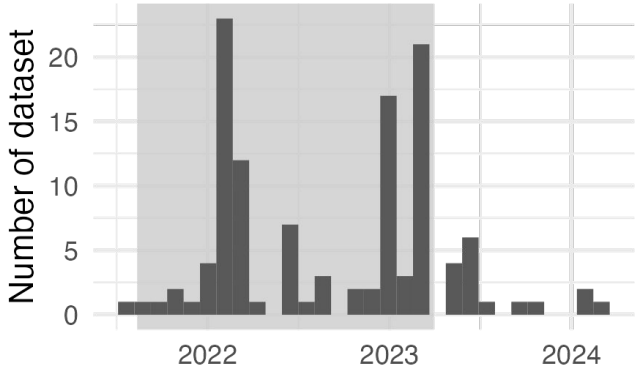
* ZIG to ZooSize script available

ZooSize Project timeline

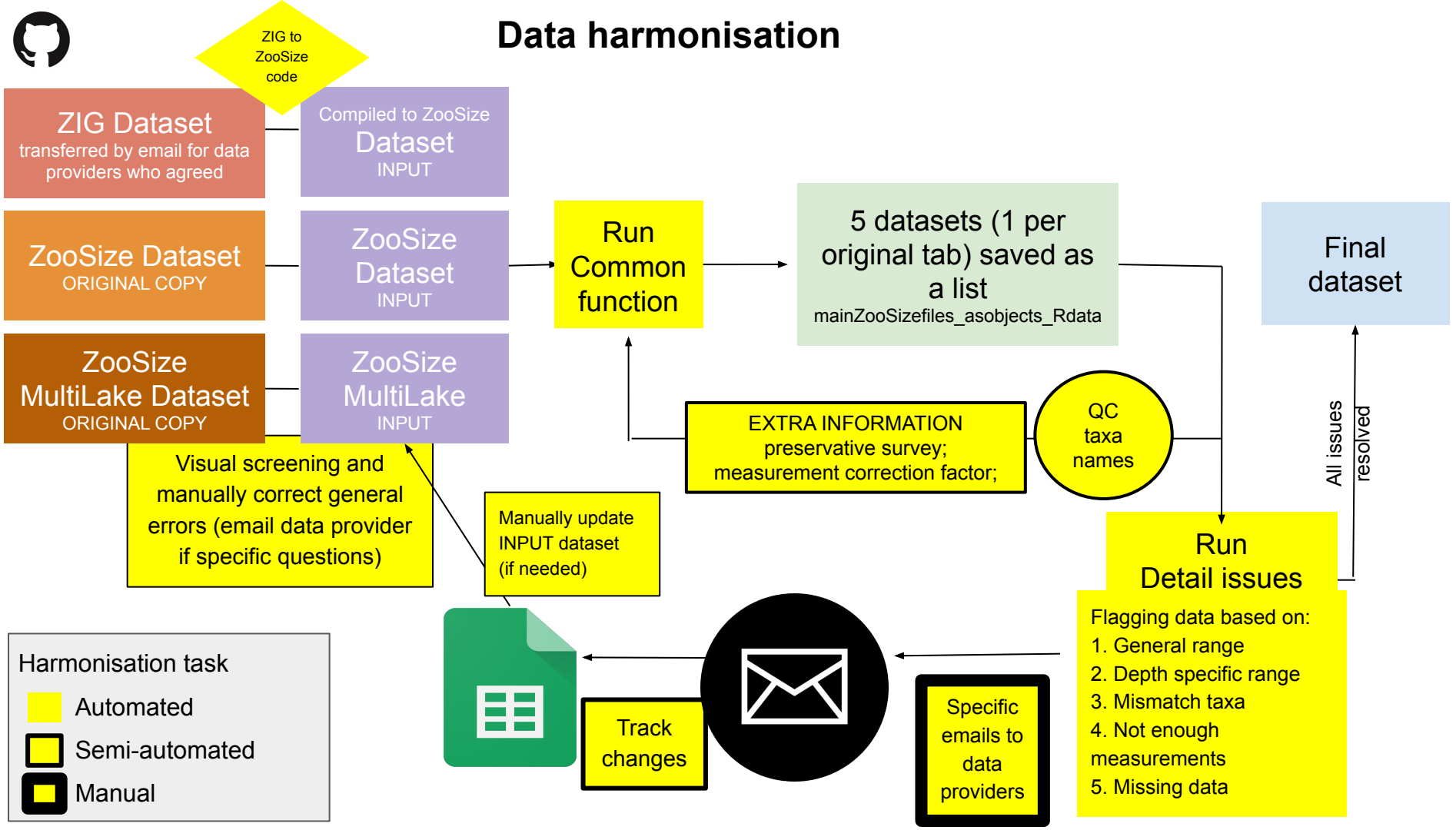
Key dates

Tracking dataset submis-sion





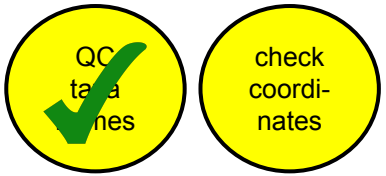
Data harmonisation



Perspectives on our data harmonisation approach

Pros:

- Easy to include a new dataset (one unique script)
- When entry data do not have any errors, it is easy to merge them to the general dataset (⅖ of the datasets had no flag at all, only ⅕ dataset had >5 issues)
- The script allowed us to compartmentalize the issues and solve them one by one



Cons:

- although most errors are small and easily fixed, we still have to include a manual step of back and forth with data providers to double check errors
- we reached a wall with that step that requires a lot of concentration to keep track of emails.

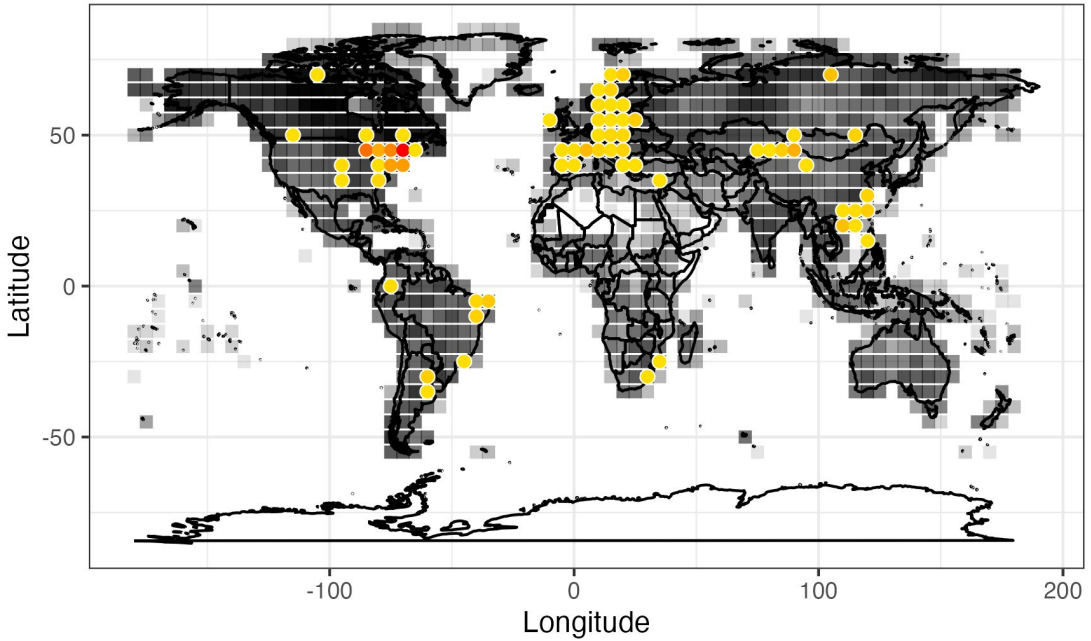
⇒ Future solution could be to implement automatic verifications in the data template (e.g., secchi depth cannot be greater than lake maximum depth, flag TP/TN values if greater than expected range, etc.).

Manual taxa names harmonization may be required no matter what.
The step helped reduce mismatches between the tab “Zoo counts” and “Zoo size”.

The ZooSize dataset

360 lakes

51 data providers



3833 observations
median = 1 observation per lake
max = 706 observations for one lake

Number of lakes ≥10ha in the HydroLakes database (Messager et al, 2016)

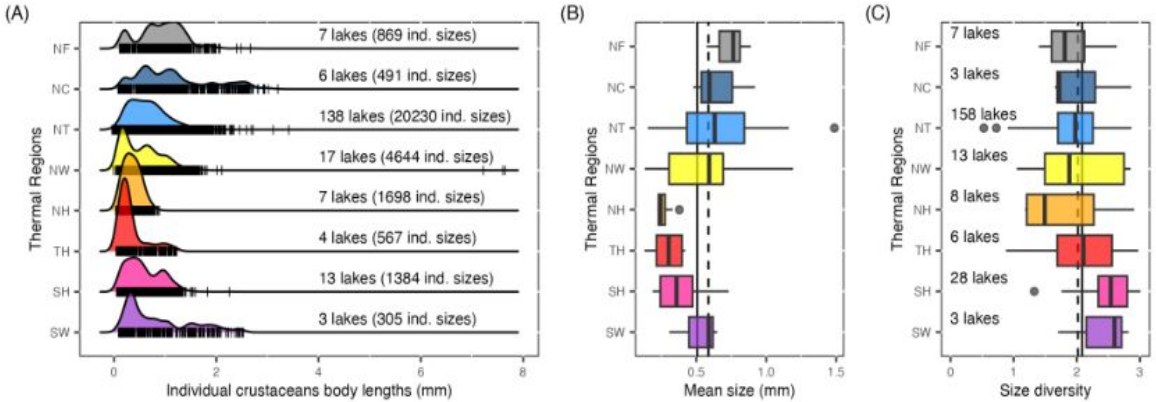
0 20 140 1800 22020

Number of lakes in the ZooSize dataset

20 40 60

Preliminary analysis:

- mean size vary greatly across thermal region
- mean size and size diversity give two different information about community structure



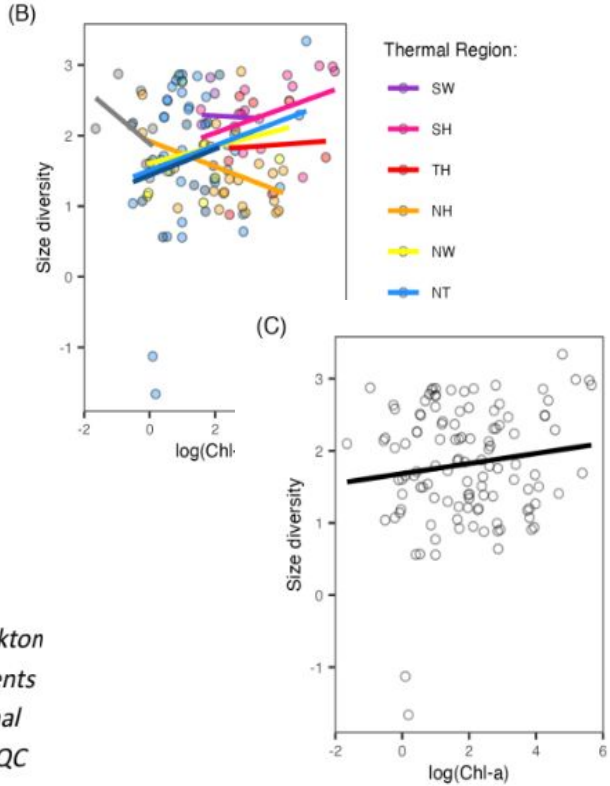


***Figure 2**. (A) Size distributions, (B) community geometric mean size, and (C) size diversity for crustacean zooplankton per thermal region (colors - see Fig. 1 for key). In (A), Number of lakes and number of individual size measurements are shown per thermal region. Dashed and full vertical lines in (B-C) are averages across the dataset and thermal regions respectively. Discrepancies in number of lakes between (A) and (C) come from some different levels of QC progress; the final result will look slightly different.*

Size diversity vs. chlorophyll-a

Insights from global data collection effort

- Biggest difficulty: not having ZooSize clearly identified as a project for either of us (~90% of the time spent on ZooSize was “voluntary” work) ⇒ we are hoping to find a way to finance a few months of postdoc to help
- Use of project management tools (Google Drive, github, …) really helps!
- Using a common script worked for us to assemble the main dataset and allowed us to start the analyses early on.
- We used these preliminary analyses in posters and presentation
  - it may have baited new contributors :)
  - it motivated us to keep moving forward!

Next steps

- Publish the dataset as a data paper
- Test our hypotheses and write a paper using the dataset
- Perspective paper on collecting and assembling the data (joint paper with ZIG?)

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project's page

Thank you, Merci, Gracias, Obrigado/Obrigada, Danke, Grazie, Děkuji, Kiitos, Tack, Dankie, Ngiyabonga, 谢谢, Tak, Ευχαριστώ, Köszönöm, Go raibh maith agat, תודה, Paldies, Takk, Kia ora, Salamat, Dziękuję, Хвала!


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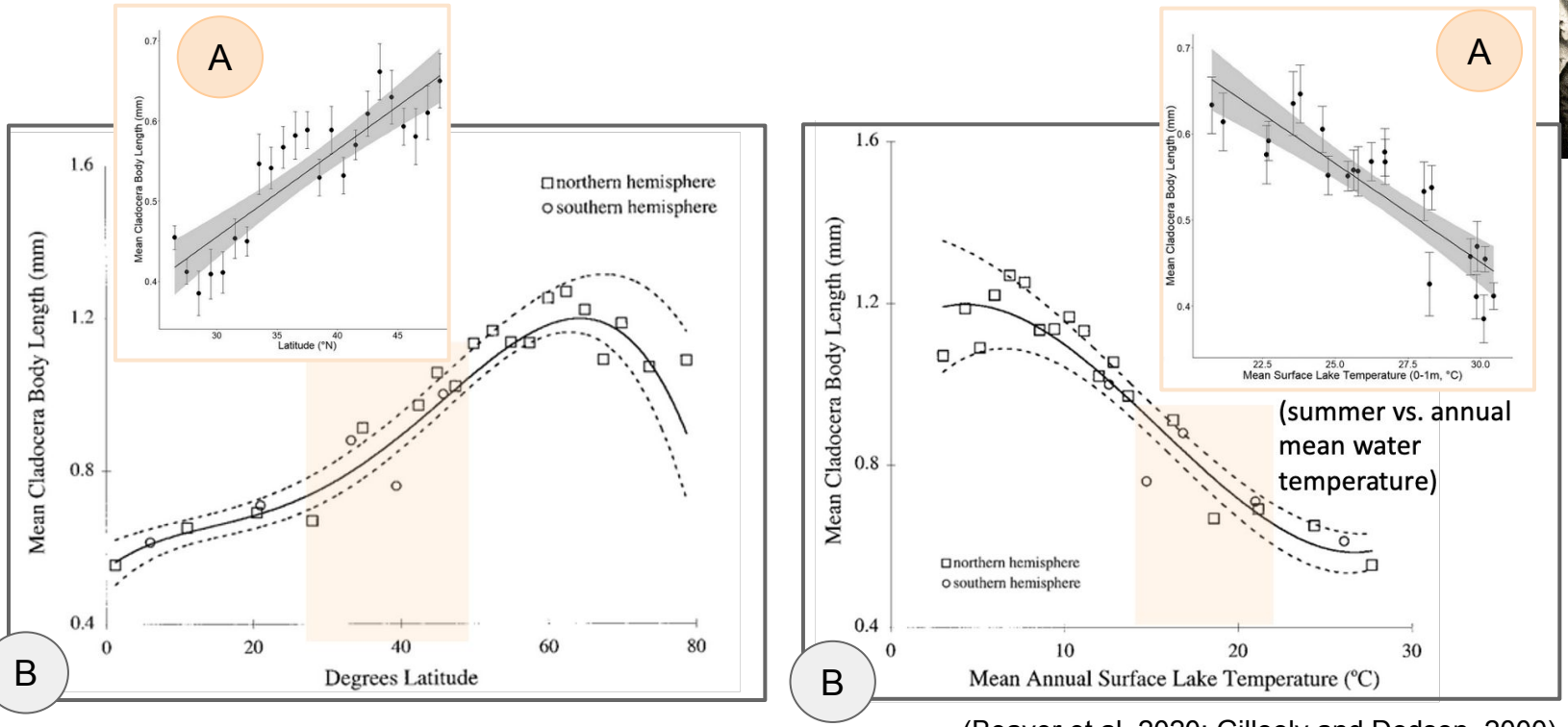
Relationships between mean size and
(1) temperature (Bergmann’s rule), (2) trophic gradient and (3) top-down pressure

Relationships between mean size and
(1) **temperature (Bergmann's rule)**, (2) trophic gradient and (3) top-down pressure

A Continental USA (Beaver et al., 2020)

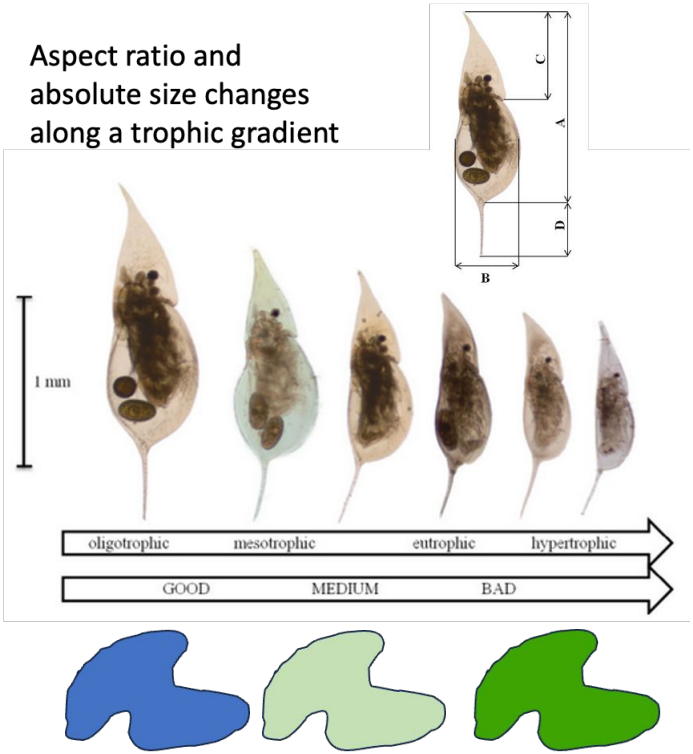
B 1100 published values (Gillooly and Dodson, 2000)

Carl Bergmann



(Beaver et al. 2020; Gillooly and Dodson, 2000)

Relationships between mean size and
(1) temperature (Bergmann's rule), (2) **trophic gradient** and (3) top-down pressure



* impact on size depends on food quality

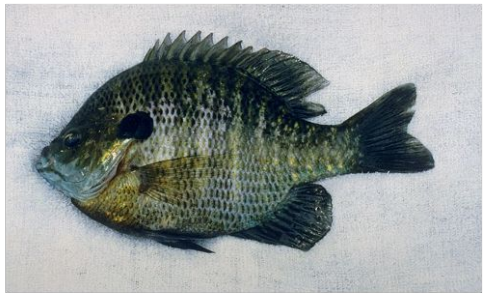
(Karpowicz et al., 2020)

Relationships between mean size and
(1) temperature (Bergmann's rule), (2) trophic gradient and (3) **top-down pressure**

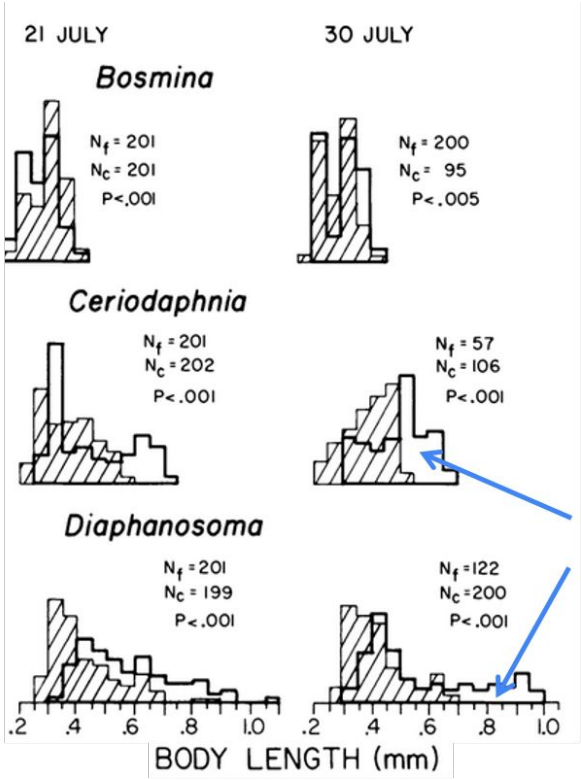
Experiment

Control

Fish treatment



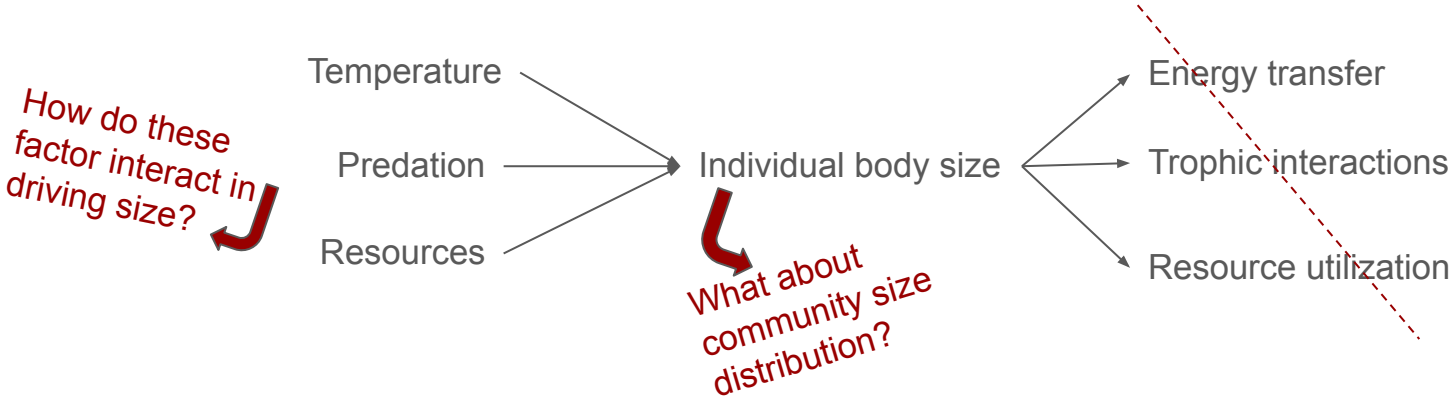
Bluegill sunfish
Lepomis macrochirus



Loss of largest individuals + reproduction at smaller size + production of smaller offspring in the fish treatment

(Vanni, 1986, 1987)

Framework of the study



Hypothesis: temperature * resources * predation INTERACTIONS!