Supporting Information

Differences in trait affinities obtained by trait aggregation methods compared to traits assigned at family-level

Comparison of the trait aggregation methods with each other

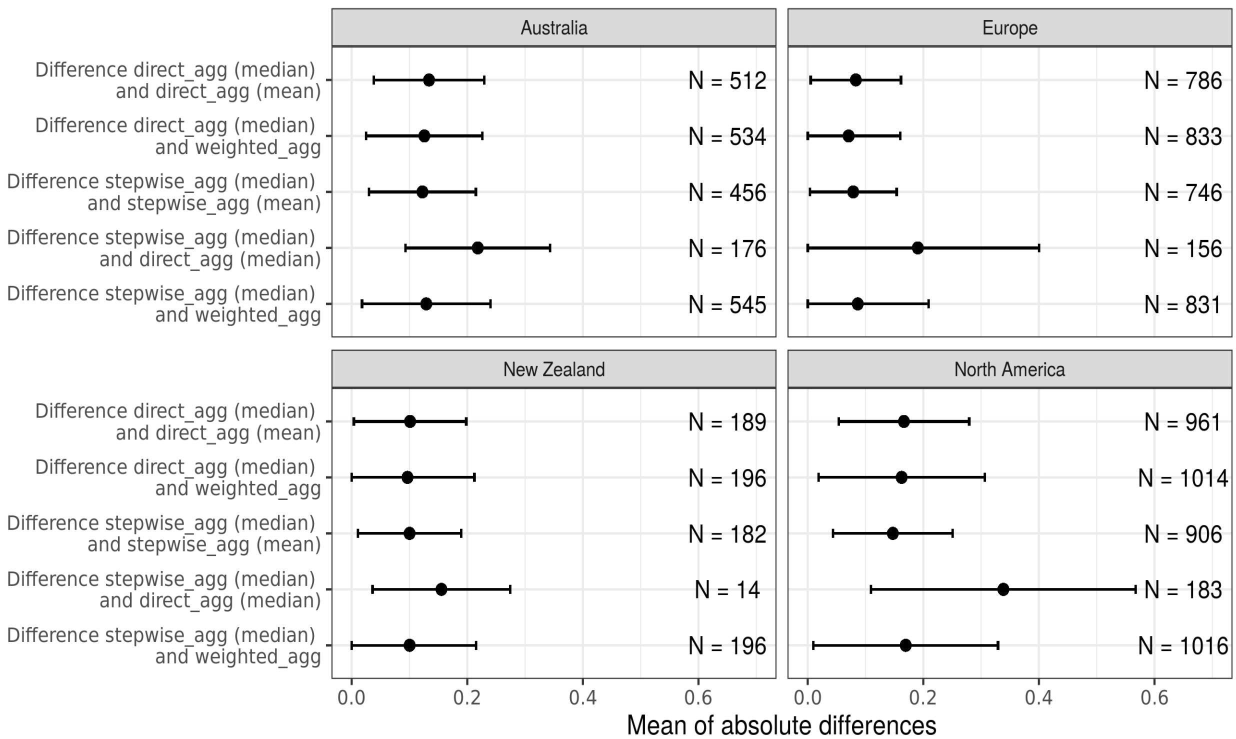

Figure 1: Comparison of trait aggregation methods when aggregating over all traits for all datasets. Displayed are means of absolute differences in trait affinities with standard deviations (truncated at 0). Compared aggregation methods are displayed on the y-axis. N indicates the number of cases where differences occurred. Total number of cases: Australia 2223, Europe 3352, New Zealand 777, and North America 4080.

Simulation of varying taxonomic hierarchies

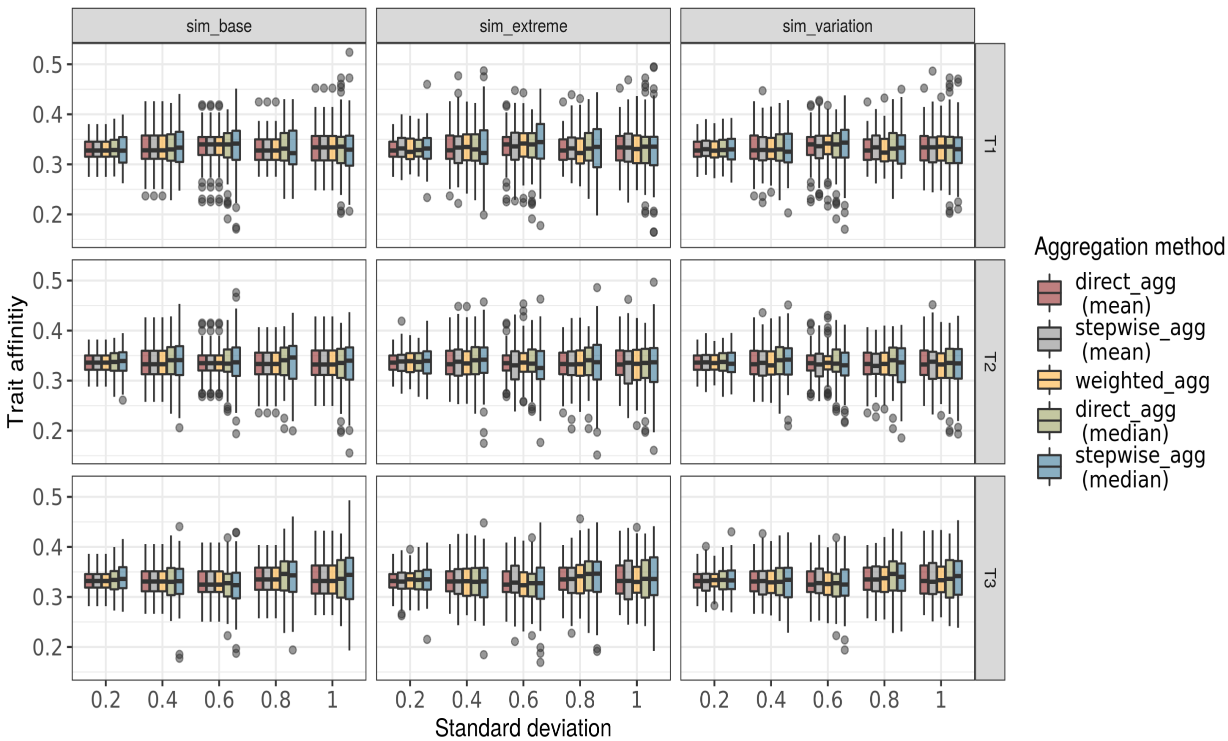

Figure 2: Ranges of aggregated trait affinities for the three examples of taxonomic hierarchies and simulated levels of trait variability. Boxplots depict results for each trait aggregation method of 100 simulations. T1 to T3 are the simulated traits.

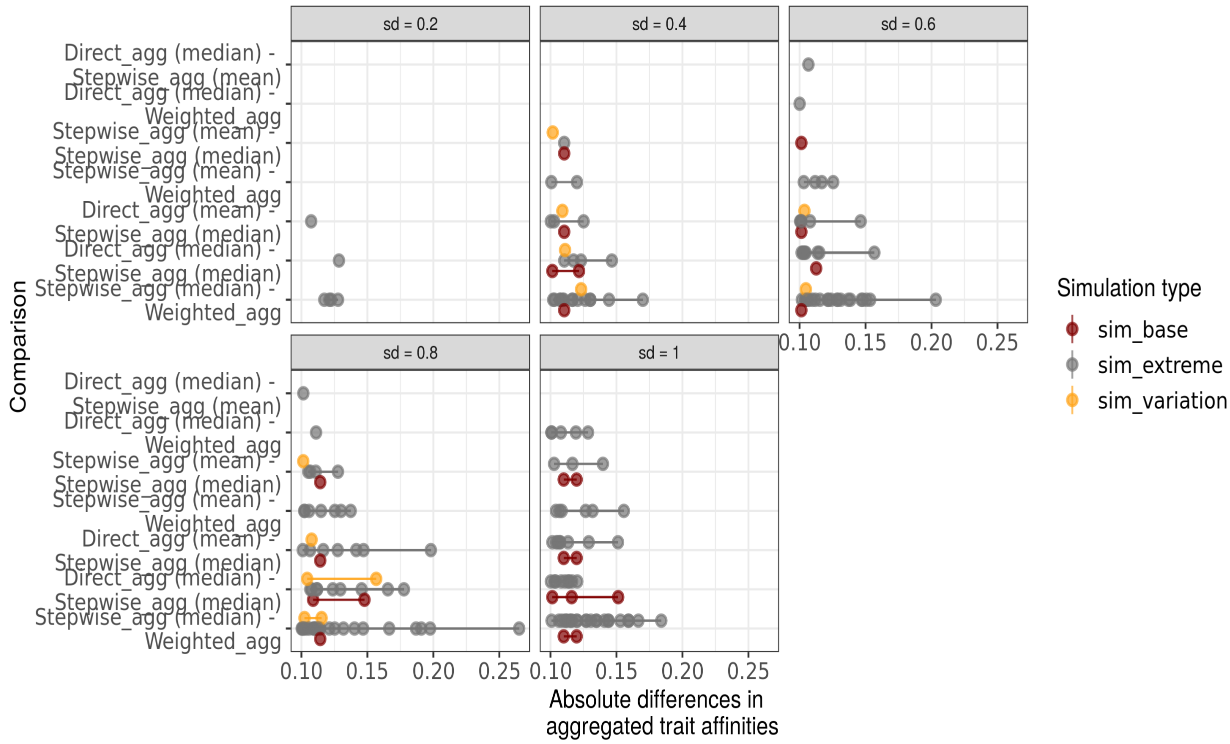

Figure 3: Comparison of the results of the trait aggregation methods for every simulated dataset. Simulated datasets where absolute differences between aggregated trait affinities were greater than 0.1 are depicted. Only the comparisons are shown were differences greater than 0.1 occurred.

Taxonomic hierarchy in the analysed trait datasets

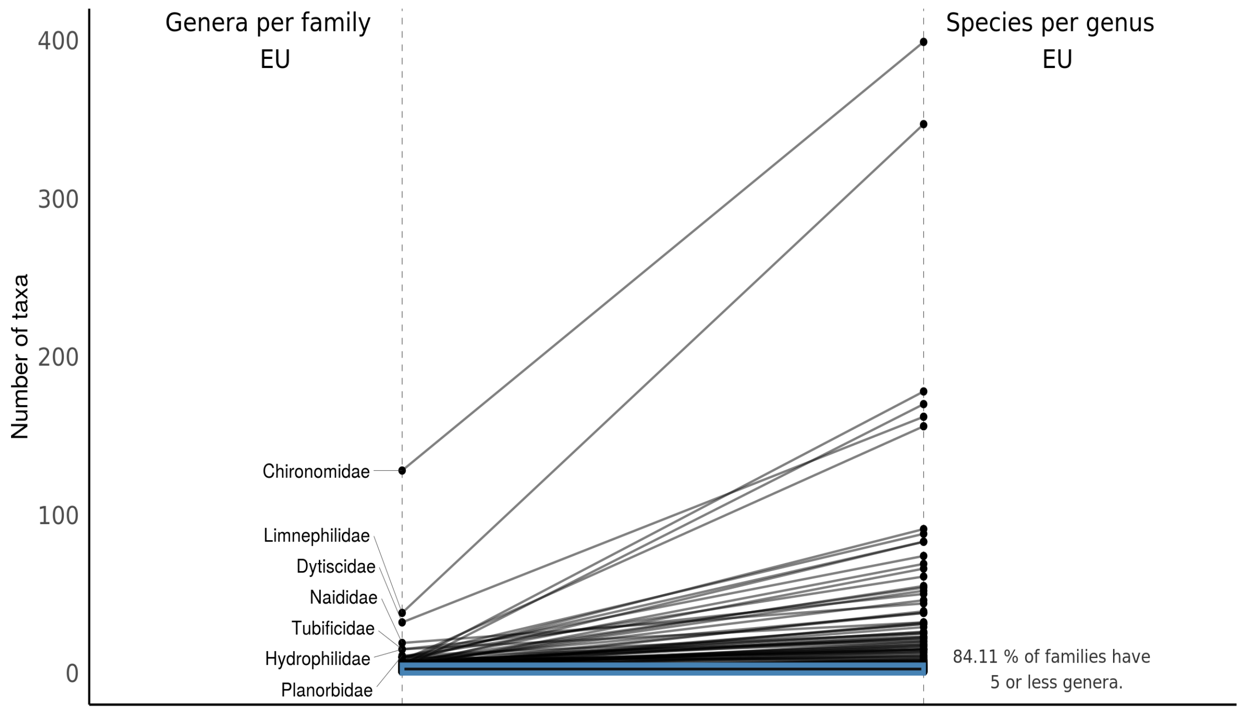

Figure 4: Number of genera per family and species per genus for the European trait dataset. For better visual display only families with more than 10 genera are displayed.

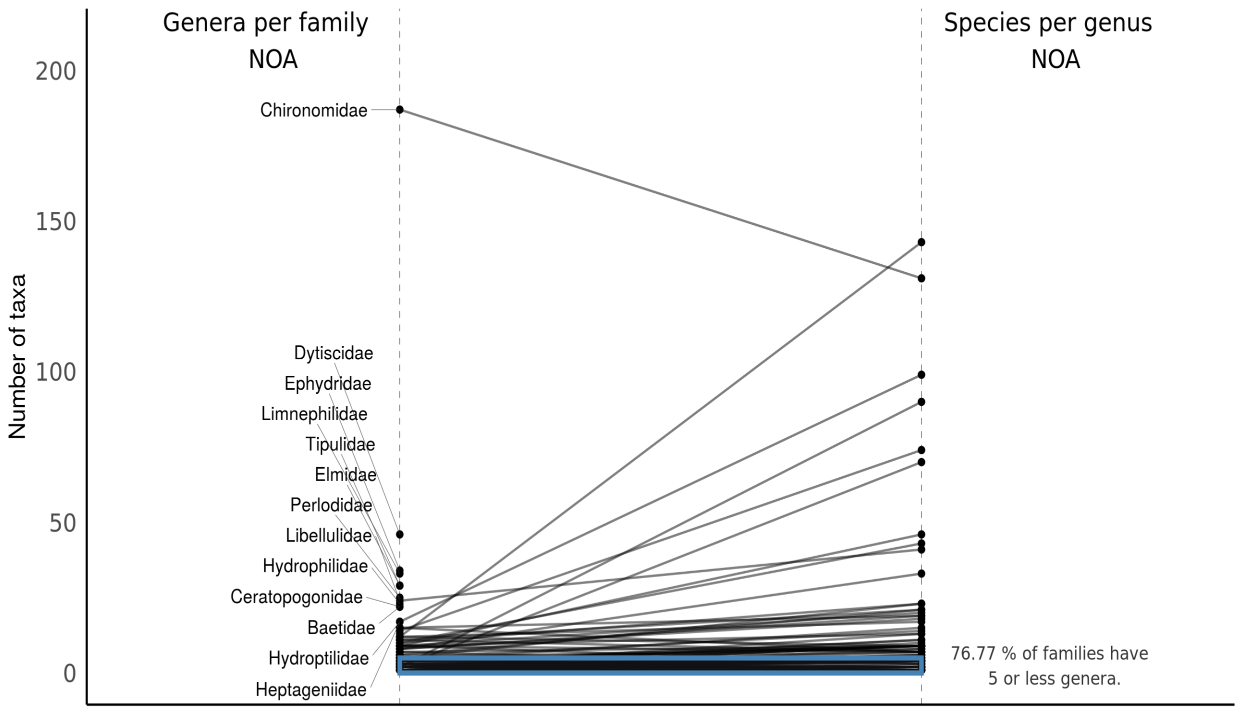

Figure 5: Number of genera per family and species per genus for the North American trait dataset. For better visual display only families with more than 15 genera are displayed.

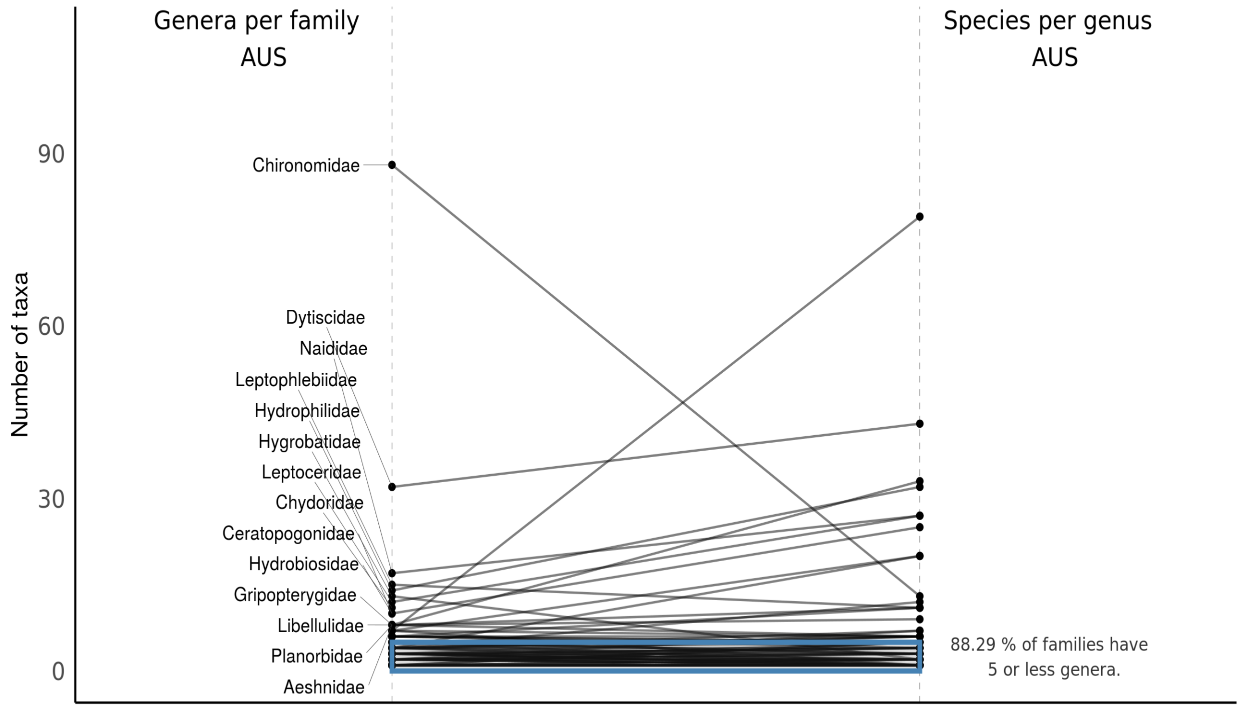

Figure 6: Number of genera per family and species per genus for the Australian trait dataset. For better visual display only families with more than 7 genera are displayed.

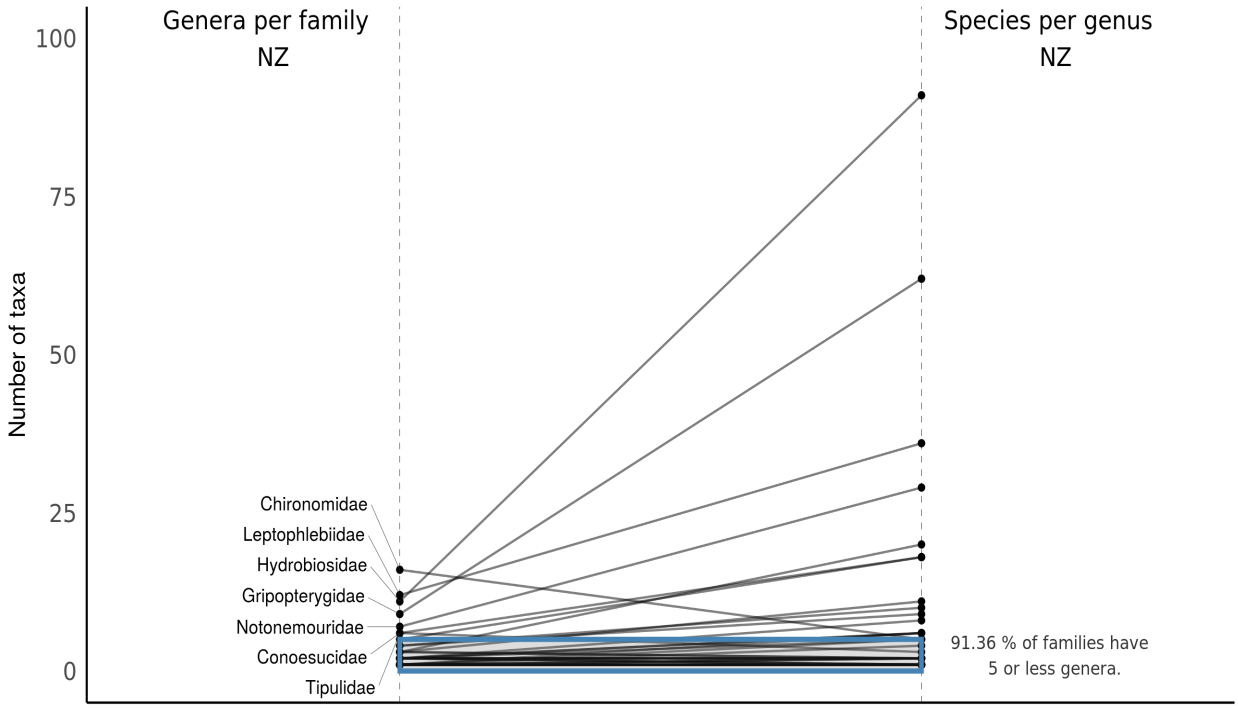

Figure 7: Number of genera per family and species per genus for the New Zealand trait dataset. For better visual display only families with more than 5 genera are displayed.

Re-analysis of Szöcs et al. using harmonized grouping features.

RDA of trait composition

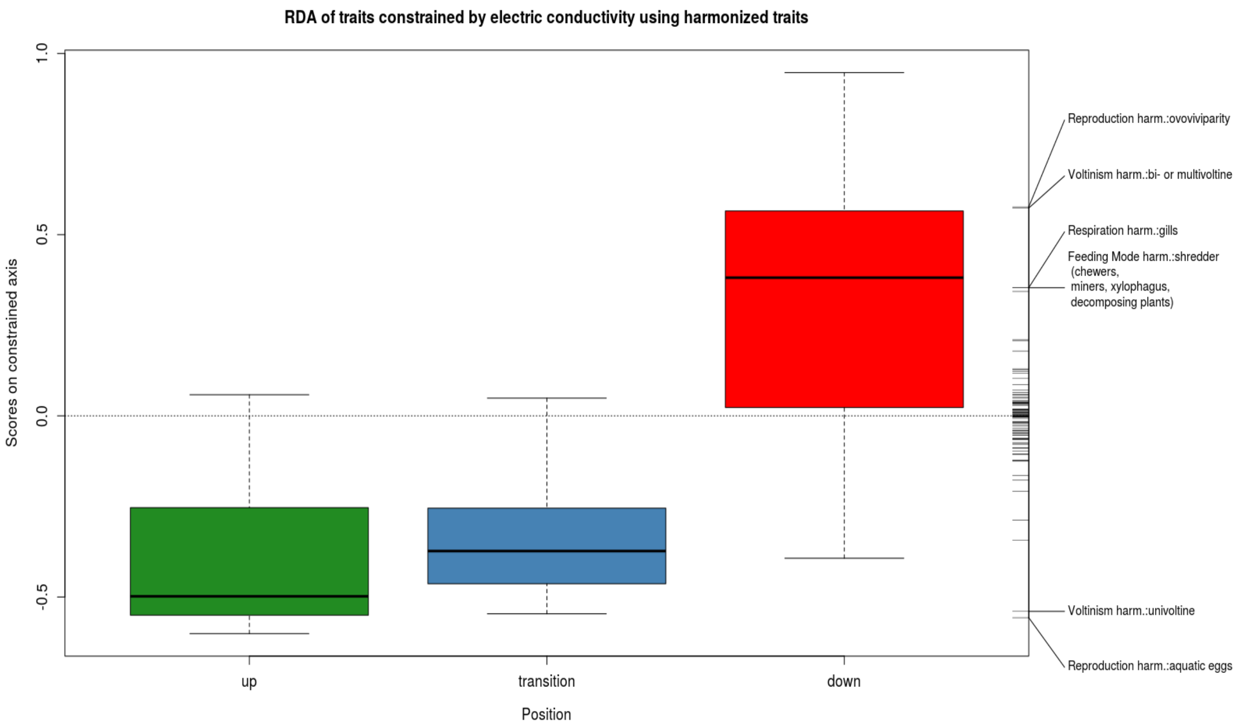

Figure 8: RDA of traits constrained by electric conductivity using harmonized grouping features. Boxplot of site scores along the conductivity axis (31.44% explained variance, p = 0.001, 1000 permutations). Rug on the right indicates trait scores on the conductivity axis. Only traits with a mahalanobis distance greater than 5.02 were labeled in accordance to the procedure in Szöcs et al. [1].

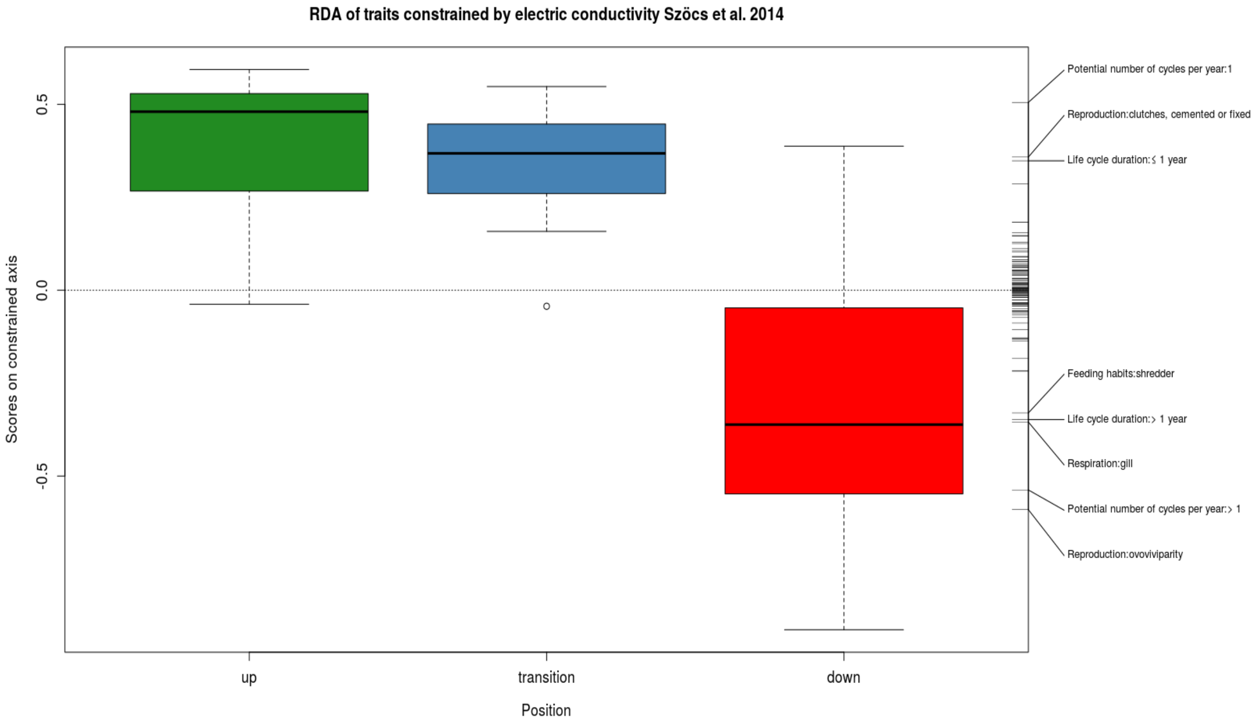

Figure 9: RDA of traits constrained by electric conductivity. Boxplot of site scores along the conductivity axis (30.09% explained variance, p = 0.001, 1000 permutations). Rug on the right indicates trait scores on the conductivity axis. Only traits with a mahalanobis distance greater than 5.02 were labeled.

Trait distribution along first RDA axis

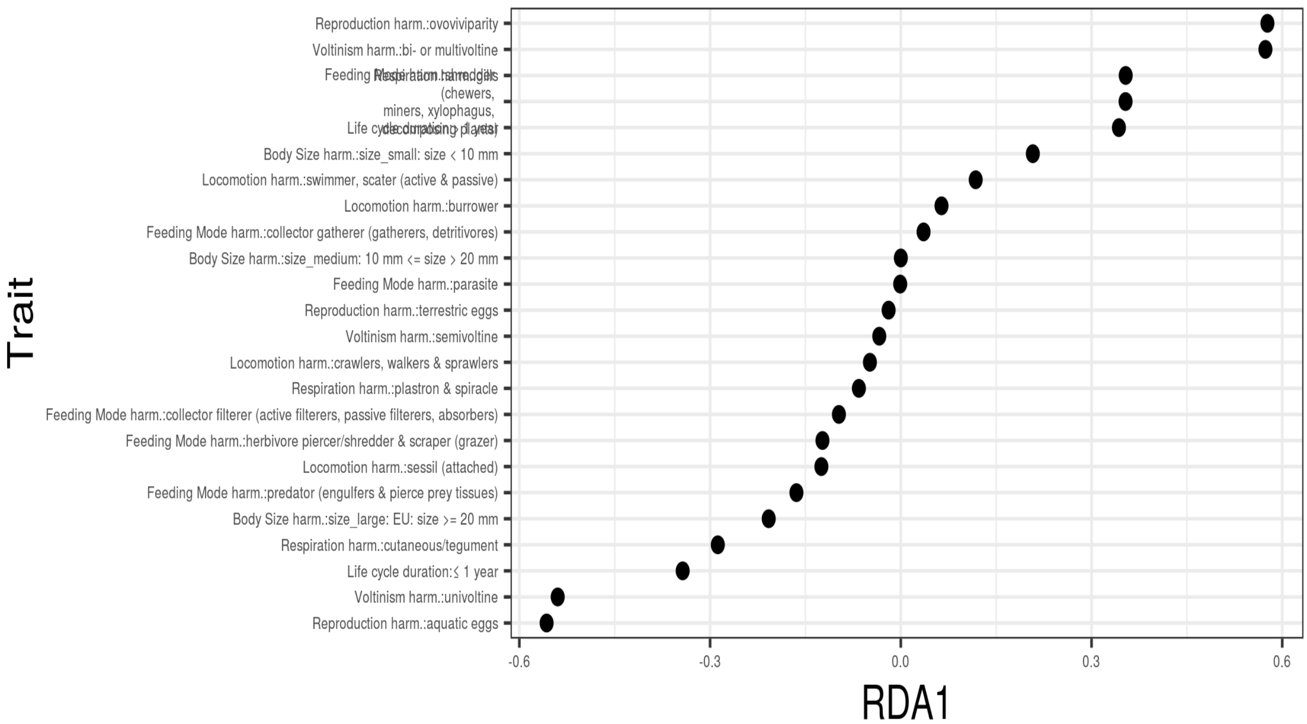

Figure 10: Trait scores on the first RDA axis for harmonized traits and traits of the grouping feature *life cycle duration*.

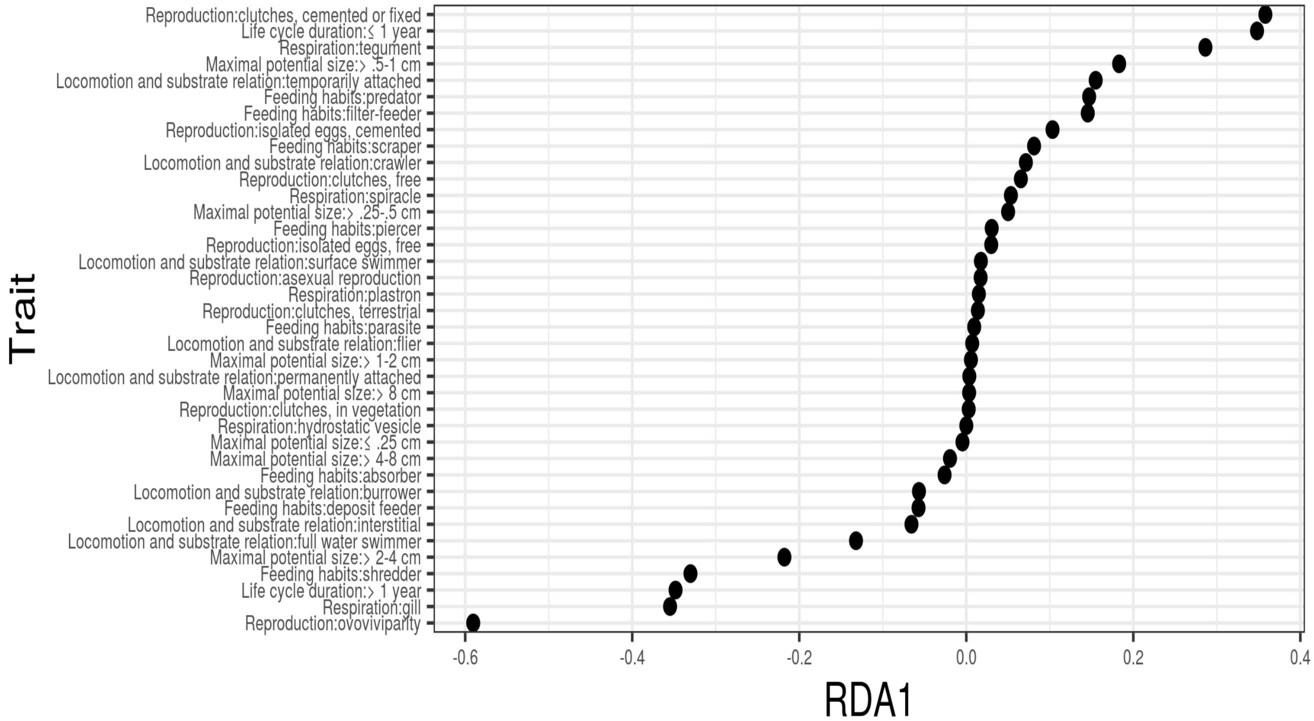

Figure 11: Trait scores on the first RDA axis for the traits responding to high salinity in Szöcs et al. [1] .

Linear models of trait proportions

Linear models of trait proportions with harmonized traits:

Table 1: Results of linear models for the four selected harmonized traits and life cycle duration > 1 year. Trait proportions were logit transformed prior model building, estimates are on the logit scale. Although years were statistically not significant we kept this factor in the model to avoid temporal autocorrelation. Bold values indicate statistically significant effects ($p < 0.05$).

	Feeding mode: shredder	Life cycle duration: > 1 year	Voltinism: bi- or multivoltine	Reproduction: ovoviviparity	Respiration: gills
Intercept (= upstream)	**-1.041**	**-0.486**	0.375*	**-0.823**	0.092
Downstream	**0.926**	**0.605**	**1.376**	**1.684**	**0.854**
Downstream x 2008	-0.117	0.106	-0.235	-0.088	-0.317
Downstream x 2009	0.030	-0.056	0.001	0.245	0.180
Year 2008	-0.167	-0.115	0.033	-0.182	-0.151
Year 2009	0.175	0.086	-0.088	0.246	0.141

** p.value = 0.055*

Linear models of trait proportions Szöcs et al. :

Table 2: Results of linear models for the five selected traits for Szöcs et al. [1]. Trait proportions were logit transformed prior model building, estimates are on the logit scale. Although years were statistically not significant we kept this factor in the model to avoid temporal autocorrelation. Bold values indicate statistically significant effects ($p < 0.05$).

	Feeding habits: shredder	Life cycle duration: > 1 year	Cycles per year: > 1	Reproduction: ovoviviparity	Respiration: gills
Intercept (= upstream)	**-0.853**	**-0.478**	**0.603**	**-0.838**	0.111
Downstream	**0.819**	**0.594**	**1.297**	**1.679**	**0.839**
Downstream x 2008	-0.155	0.102	-0.227	-0.070	-0.314
Downstream x 2009	0.073	-0.053	-0.020	0.248	0.176
Year 2008	-0.122	-0.112	0.026	-0.192	-0.154
Year 2009	0.167	0.084	-0.104	0.250	0.139

Trait proportions over time

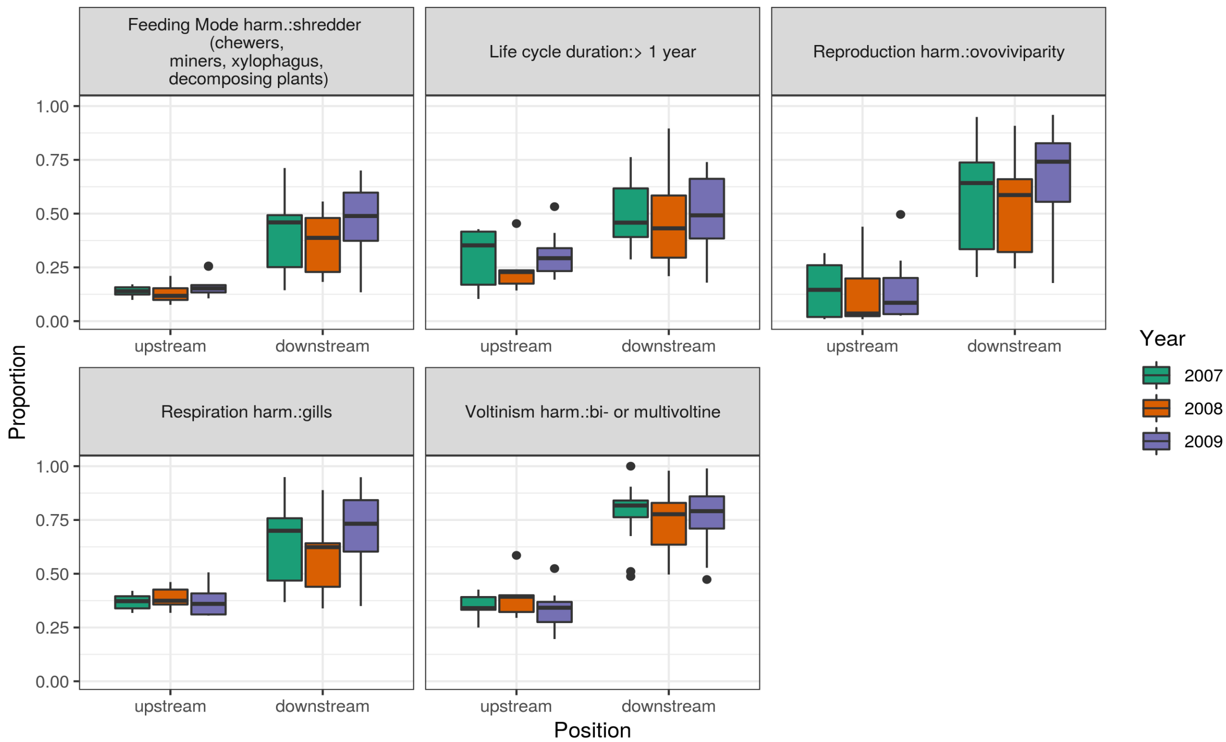

Figure 12: Proportions for the four harmonized traits that have been promoted by salinization and life cycle duration > 1 year for down- and upstream sites.

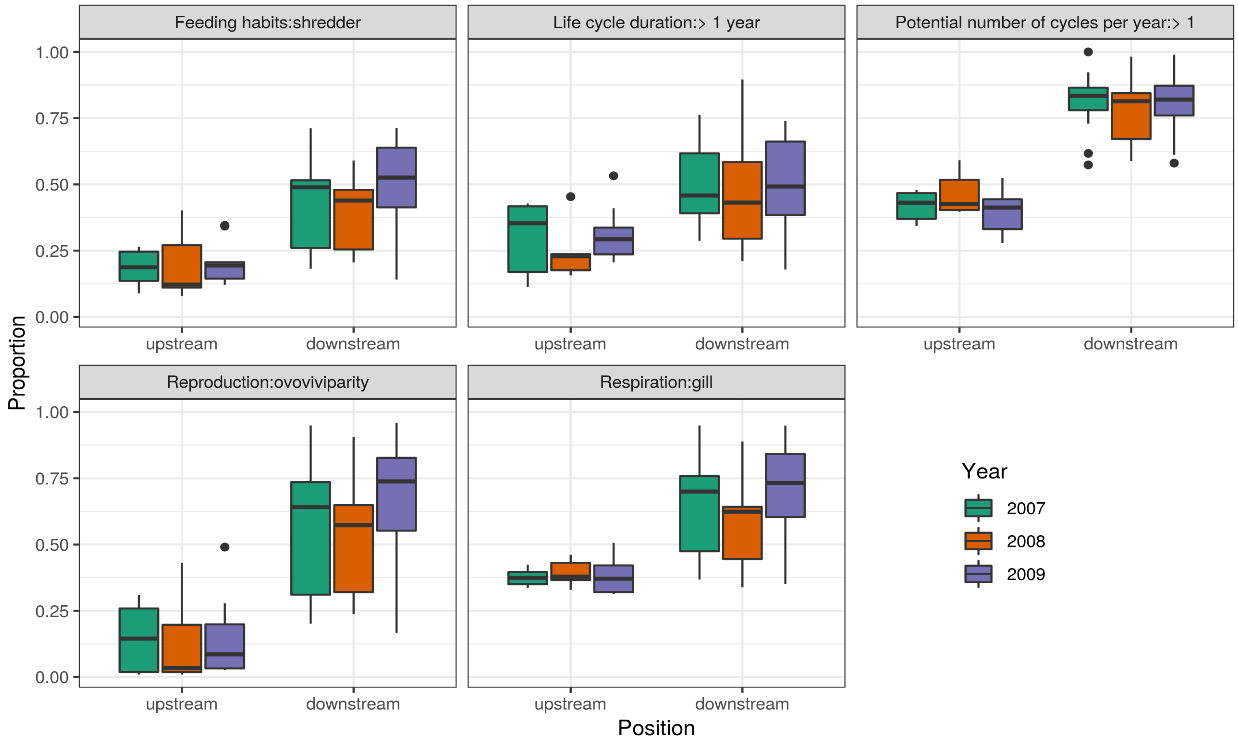

Figure 13: Proportions for five selected traits for down- and upstream sites (traits that have been promoted by salinization) from Szöcs et al. [1].

Discrepancies in trait definitions

Table 3: Comparison of trait definitions between invertebrate trait databases. Only traits that are differently described across databases are listed. The definition is quoted if it enables differences to be identified, otherwise the differences are described. The hyphen indicates a missing trait. Reproduction was captured in multiple grouping features per database. Hence, differences for reproduction have been described in the paper. Body form traits are not different between databases, except that the North America (Vieira) database contains the trait Bluff (blocky) which does not appear in the other databases.

Trait	Freshwater-ecology.info	Tachet	North America (Twardochleb)	North America (Vieira)	Australia	New Zealand
Feeding shredder	”Feed from fallen leaves, plant tissues, CPOM”	”Eat coarse detritus, plants or *animal material*”	• ”Shred decomposing vascular plant tissue” • Trait herbivore includes among others insect that shred *living aquatic plants*	Shredder	• Detrivore [a] • Trait herbivore includes among others the trait shredder	Shredders

Feeding predator	"Eating from prey"	• Carvers, engulfers & swallowers • Piercers (plants & animals) are an additional trait	Engulfers ("ingest prey whole or in parts") & piercers ("prey tissues and suck fluids")	Predator	Piercer & engulfer	Predator
Feeding filter-feeder	Distinguishes between active and passive	No distinction between active and passive	No distinction between active and passive	No distinction between active and passive	No distinction between active and passive	No distinction between active and passive
Semivoltine	"One generation in two years"	"Life cycle lasts *at least* two years"	"$<$ 1 generation per year"	"$<$ 1 generation per year"	"$<$ 1 generation per year"	"$<$ 1 reproductive cycle per year"
Multivoltine	"*Three* or more generations per year" [b]	"Able to complete *at least* two successive generations per year"	"$>$ 1 generations per year"	"$>$ 1 generations per year"	• 1-2 generations per year • bi/multivoltine • up to 5 generations per year • up to 10 generations per year	"$>$ 1 reproductive cycles per year"

Locomotion swimming	• Passive movement like floating or drifting (trait swimming/scating) • Active movement (trait swimming/diving) .	• Surface swimmers (over and under the water surface) • Full water swimmers (e.g. Baetidae).	”Adapted for ”fish-like” swimming”	Swimmer	Distinguishes swimmer and skater	Swimmers (water column)
Locomotion burrowing	”Burrowing in *soft* substrates or boring in *hard* substrates”	• Burrowing ”within the first centimeters of the benthic fine sediment” • Differentiates also the trait interstitial (endobenthic)	”Inhabiting *fine* sediment of streams and lakes”	Burrower	”Moving deep into the substrate and thus avoiding flow”	Burrowers (infauna)
Locomotion sprawling & walking	”Sprawling or walking actively with legs, pseudopods or on a mucus”	-	Sprawling: ”inhabiting the surface of floating leaves of vascular hydrophytes or fine sediments”	Sprawler	-	-

Locomotion crawling	-	"Crawling over the bottom substrate"	Defined as crawling on the surface of floating leaves or fine sediments on the bottom	-	Database contains traits crawler, sprawler, climber and clinger.	Crawlers (epibenthic)
Locomotion sessil	Does not distinguish temporarily and permanently attached	Distinguishes temporarily and permanently attached	Does not distinguish temporarily and permanently attached	Does not distinguish temporarily and permanently attached	Distinguishes temporarily and permanently attached	Does not distinguish temporarily and permanently attached
Respiration plastron & spiracle	Plastron and spiracle (aerial) are two separate traits	Definition includes respiration using air stores of aquatic plants	Plastron and spiracle combined into one trait	Distinguishes spiracular gills, plastron, atmospheric breathers and plant breathers	Plastron and spiracle (termed aerial) occur as separate and combined traits. Contains also traits: air (plants), atmospheric, and functional spiracles	Distinguishes plastron and spiracle (termed aerial)
Body size small	-	Multiple size classifications [d]	< 9 mm	< 9 mm	< 9 mm [a;c]	Multiple size classifications [e]
Body size medium	-		9 - 16 mm	9 - 16 mm	9 - 16 mm	
Body size large	-		> 16 mm	> 16 mm	> 16 mm	

a Traits from Botwe et al.
b Contains also bivoltine (two generations per year), trivoltine (three generations per year) and flexible.
c Contains a size trait with numeric size values. Contains also traits classifying size like Tachet and like the North American trait databases.
d Size classifications: $<= 0.25\ cm$, $> 0.25-0.5\ cm$, $0.5-1\ cm$, $1-2\ cm$, $2-4\ cm$, $4-8\ cm$, $> 8\ cm$. No distinction into small, medium and large.
e Size classifications: $> 0.25-0.5\ cm$, $0.5-1\ cm$, $1-2\ cm$, $2-4\ cm$, $4-8\ cm$. No distinction into small, medium and large.