Appendix S1

Supporting information for:

Impacts of extreme climatic events on trophic network complexity and multidimensional stability

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in *Ecology*

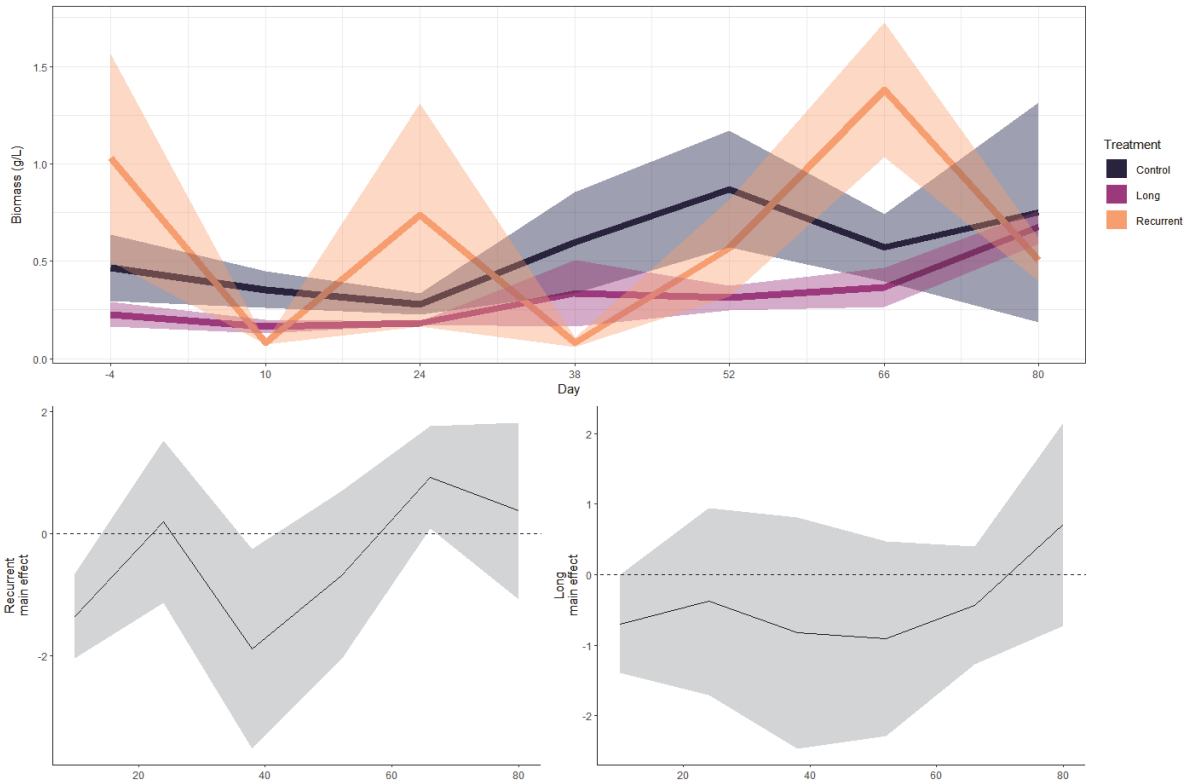

Fig. S1 | Biomass dynamics over the experimental time.
Upper panel: Total biomass dynamics over time. Total biomass was calculated as the sum of the biomass of all individuals in the experimental mesocosms (independently from the organism group to which they belong). The coloured solid lines are the average biomass over time in the different treatments, whereas the shaded coloured areas around the solid lines are standard error of the mean of the different treatments.
Lower panels: Temporal dynamics of effect sizes of the treatment (and 95% confidence intervals, shaded grey area) of a linear mixed effects models (LMM) of total biomass, for the reoccurring HWs treatment (lower left panel), and long HW treatment (lower right panel). LMM had long and reoccurring HW as fixed effects whereas mesocosm ID and day were used as random effects.

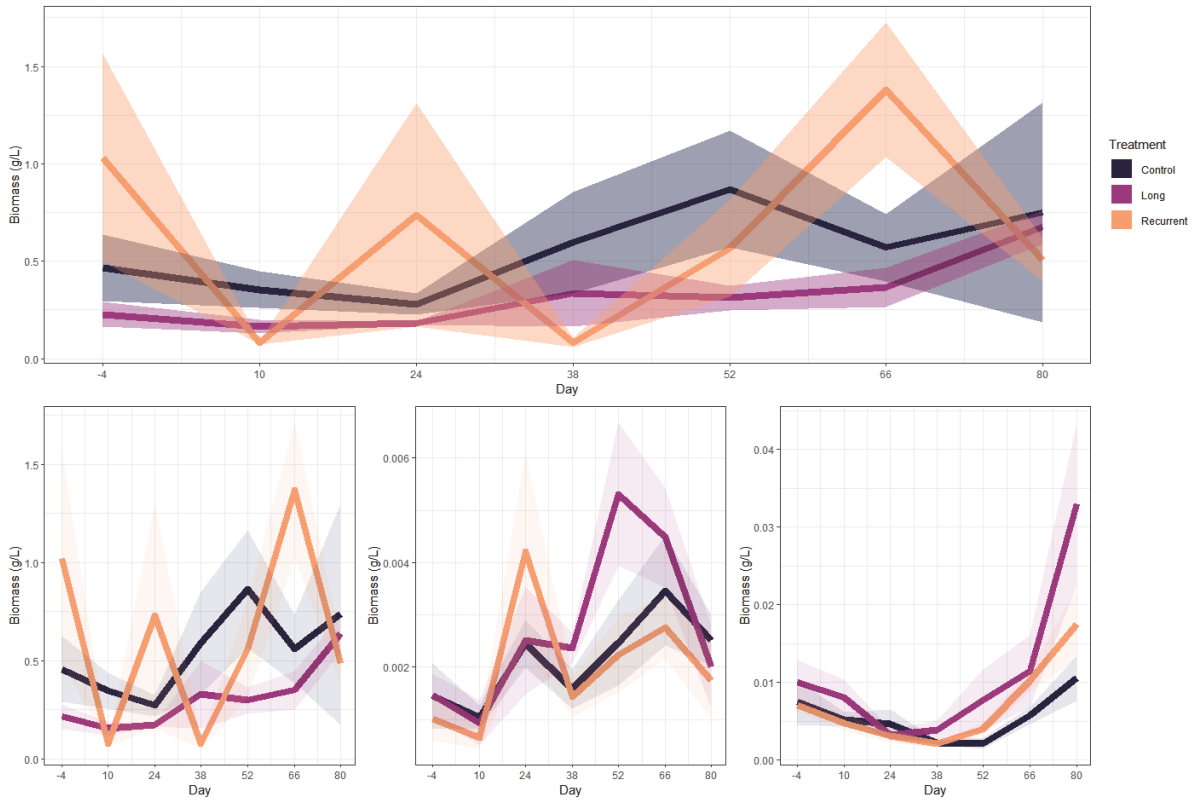

Fig. S2 | Biomass dynamics of the different organism groups.
Upper panel: Total biomass dynamics over time. Total biomass was calculated as the sum of the biomass of all individuals in the experimental mesocosms (independently from the organism group to which they belong). Lower panels: Temporal dynamics biomass of basal species (left lower panel), zooplankton (central lower panel), and macroinvertebrates (right lower panel). For all the plots, the coloured solid lines are the average biomass over time in the different treatments, whereas the shaded coloured areas around the solid lines are standard errors of the mean of the different treatments.

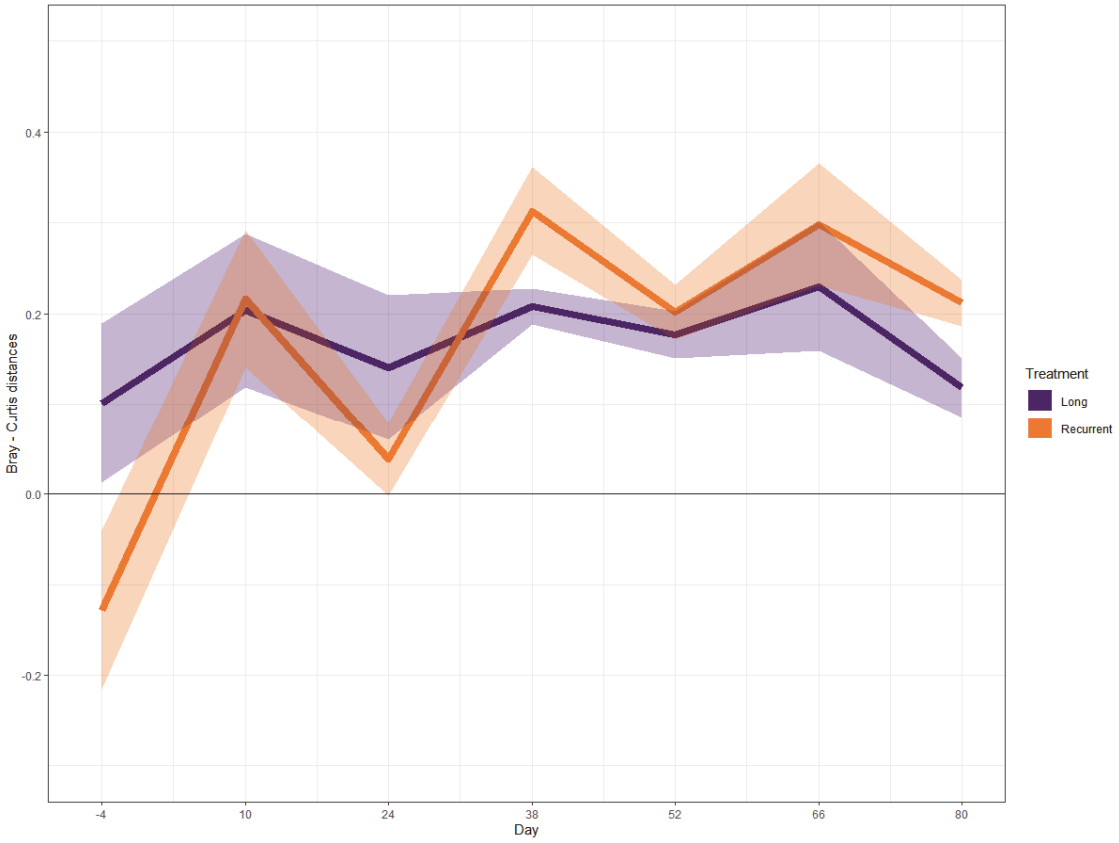

Fig. S3| Bray - Curtis dynamics over time.

Bray – Curtis distances from the control over the experimental time for the whole community. Here, whole community refers to all the organism groups analysed together. The solid line at zero represents the control, whereas the coloured solid lines are the average Bray – Curtis distances relative to the control over time of the different treatments, and the shaded areas around the coloured solid lines are standard errors of the mean.

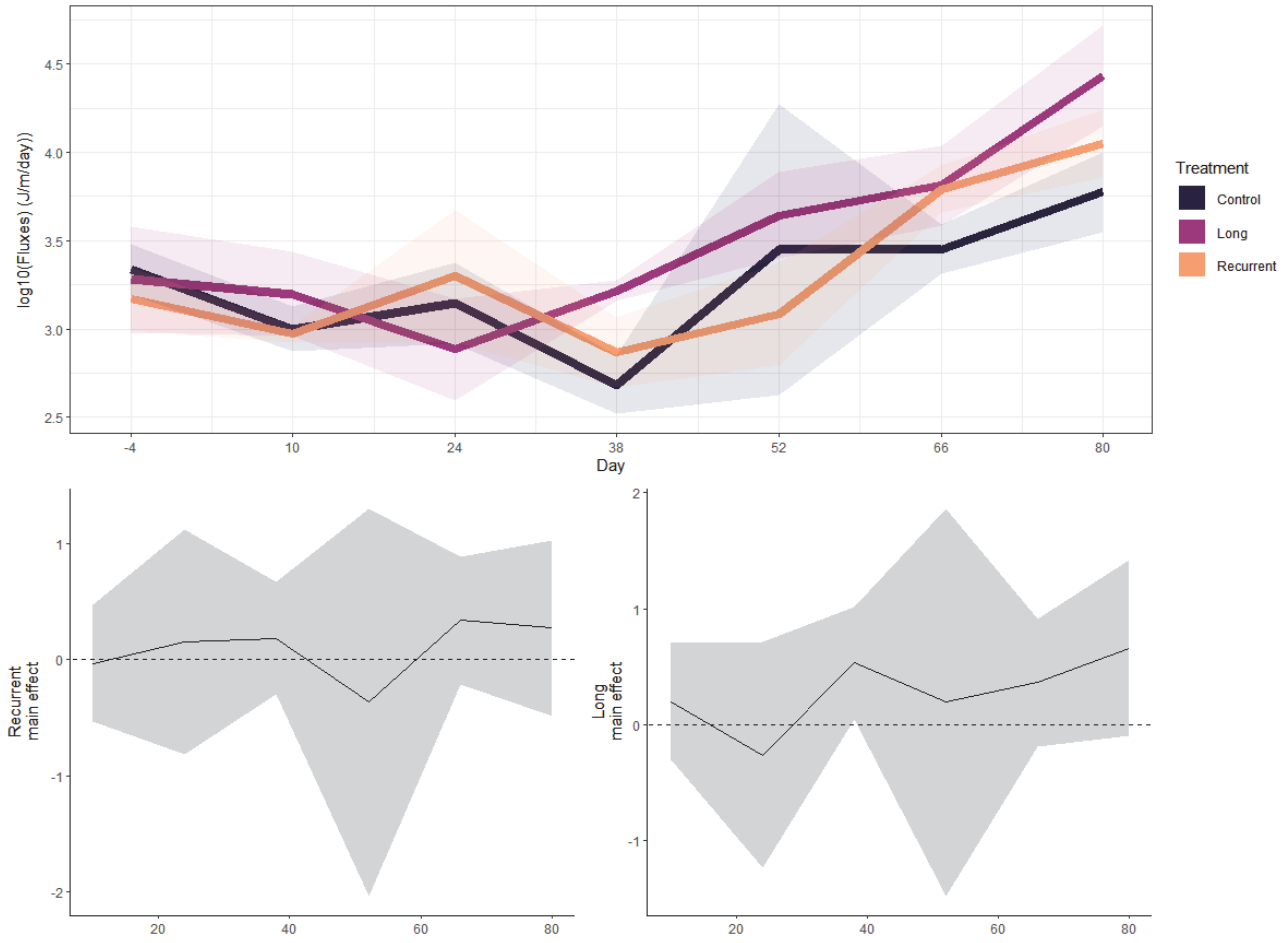

Fig. S4| Energy fluxes dynamics over the experimental time.
Upper panel: Total energy fluxes dynamics over time. Total energy fluxes was calculated as the sum of the energy fluxes of all organism groups and trophic levels of the network. The coloured solid lines are the average energy fluxes over time in the different treatments, whereas the shaded coloured areas around the solid lines are standard error of the mean of the different treatments.
Lower panels: Temporal dynamics of effect sizes of the treatment (and 95% confidence intervals) of a linear mixed effects models (LMM) of total energy fluxes, for the reoccurring HWs treatment (lower left panel), and long HW treatment (lower right panel). LMM had long and reoccurring HW as fixed effects whereas mesocosm ID and day were used as random effects.

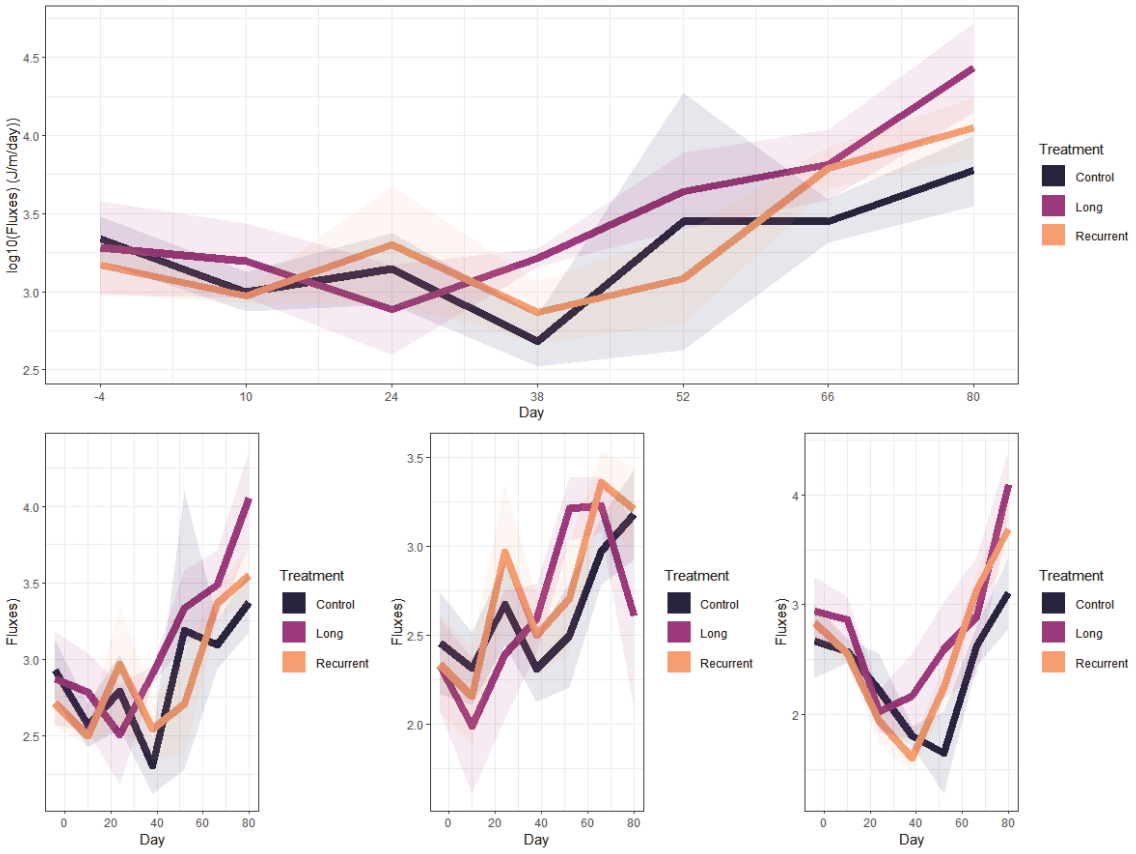

Fig. S5 | Energy fluxes dynamics of the different organism groups.
Upper panel: Total energy fluxes dynamics over time. Total energy fluxes was calculated as the sum of the energy fluxes of all organism groups and trophic levels of the network. Lower panels: Temporal dynamics energy fluxes of basal species (left lower panel), zooplankton (central lower panel), and macroinvertebrates (right lower panel).
For all the plots, the coloured solid lines are the average biomass over time in the different treatments, whereas the shaded coloured areas around the solid lines are standard errors of the mean of the different treatments.

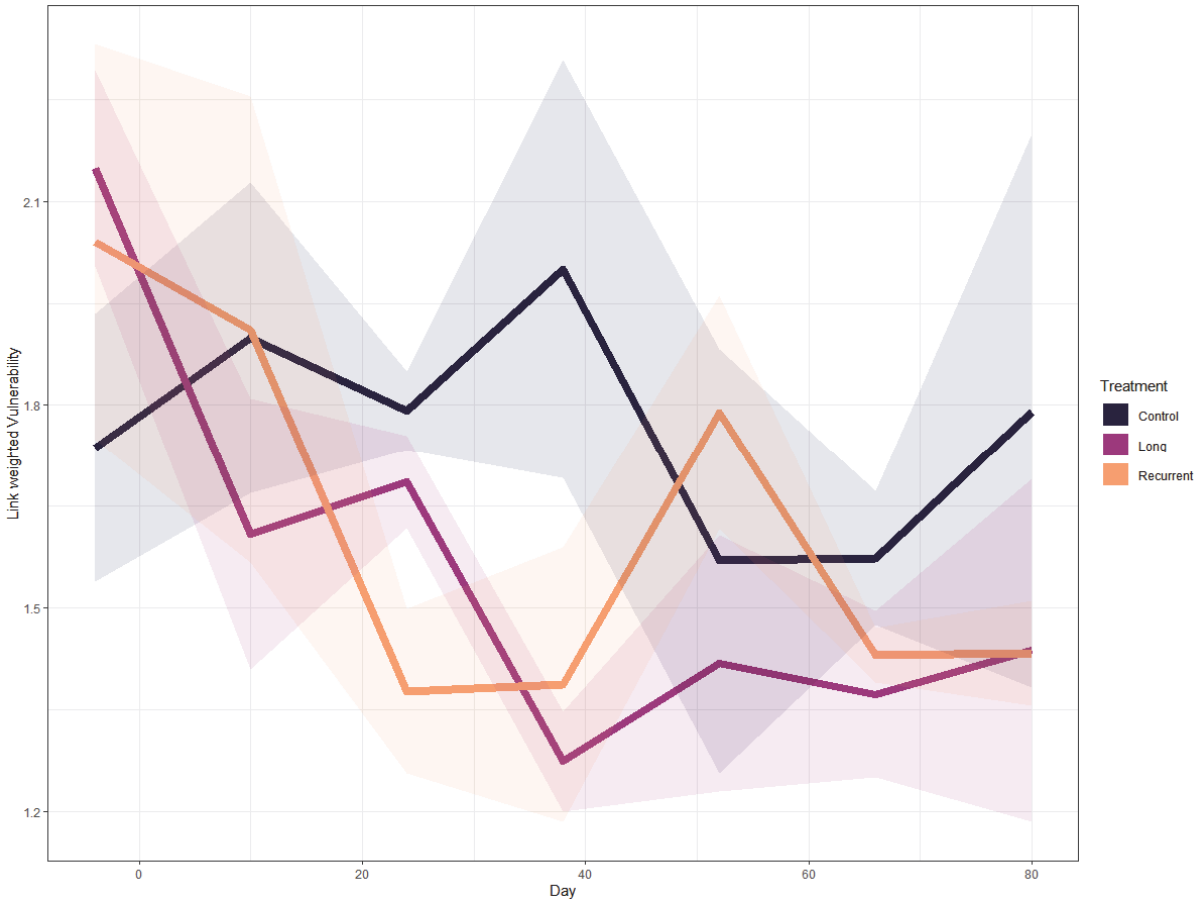

Fig. S6 | Link-weighted vulnerability dynamics over time.

Values of the link-weighted vulnerability in the different treatments over time. The coloured solid lines are the average biomass over time in the different treatments, whereas the shaded coloured areas around the solid lines are standard errors of the mean of the different treatments.

Table S1| Effects of the temperature treatments on community composition. For the permutational multivariate analysis of variance (PERMANOVA), we report F value with degrees of freedom (F) and p-values (P). For the analysis of similarity (ANOSIM), we report ANOSIM statistic R (r) and p-values (P). Significant results (with p-value < 0.05) are reported in bold.

		PERMANOVA		ANOSIM	
Phase		F	P	r	P
Pre	Reoccurring	0.65	0.78	0.21	0.11
	Long	0.87	0.83	0.13	0.17
HW3	Reoccurring	**3.18**	**0.002**	**0.53**	**0.008**
	Long	1.54	0.12	0.07	0.62
Recovery	Reoccurring	**1.76**	**0.035**	**0.48**	**0.02**
	Long	**1.42**	**0.043**	**0.35**	**0.04**

Two different permutation tests (PERMANOVA and ANOSIM) were conducted on Bray - Curtis distances

Table S2. List of unweighted and weighted food web properties used, definitions and relevant ecological information.

Food web	Properties	Definition / Relevance	Reference
Unweighted	Number of links	Number of trophic interactions in a food web. Represents the pathways along which matter and energy can flow.	Dunne *et al.* 2002
	Link density	Average trophic interactions per species.	Dunne et al., 2002
	Connectance	Proportion of actual interactions among possible ones. It is considered an estimator of community sensitivity to perturbations.	Dunne et al., 2002
	Generality	Number of preys of a species normalized by the average number of preys across the food web.	Bersier *et al.* 2002
	Vulnerability	Number of predators of a species normalized by the average number of predators across the food web.	Bersier *et al.* 2002
	Number of basal and top species	Species without prey (basal) and without predators (top). Basal species define the shape at the base of the food web, while top ones may have indirect effects on other species via top-down control.	Cohen & Briand 1984
	Mean and maximum trophic levels	The trophic level is an indicator of the position a species occupies in a food web resuming the distance of each species to the source of matter and energy. It represents the energy transfer efficiency from basal to top species.	Odum & Heald 1975
	Omnivory	Proportion of species that feed at different trophic levels. It provides trophic flexibility to an ecosystem.	McCann & Hastings 1997
	Path length	It is the average distance, accounted by the number of interactions, between any pair of species. Food webs with low values might face a rapid propagation of disturbances.	Albert & Barabási 2002
	Clustering coefficient	It is a measure of grouping that reflects how likely is that two connected species are part of a larger, highly connected group. High values may buffer the spread of perturbations.	Albert & Barabási 2002
Link-weighted	Connectance, Generality, Vulnerability	Interactions (links) are proportional to the magnitude of energy fluxes. Properties were calculated by estimating the average effective number of preys and predators of each taxon weighted by their relative incoming and outcoming flows.	Bersier *et al.* 2002

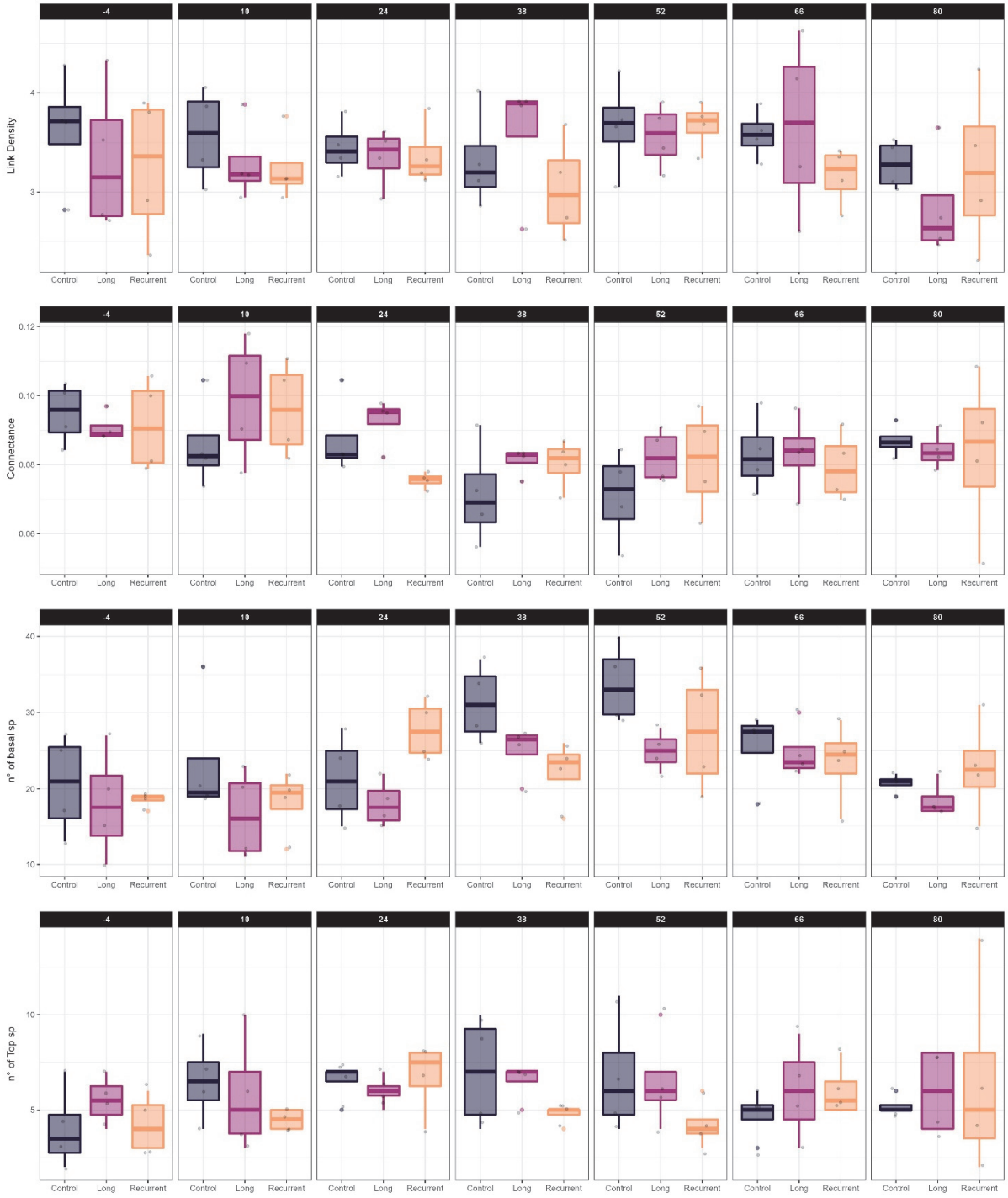

Fig. S7. Box and whisker plots ($n = 4$, for all measures) showing the responses of (from top panel to bottom panel) link density, connectance, number of basal species, and number of top species (all unweighted/topological properties of the networks) in the different phases of the experiment. For all box and whisker plots, the centre line indicates the median, while the bottom and top hinges of the box correspond to the 25th and 75th percentiles, respectively.

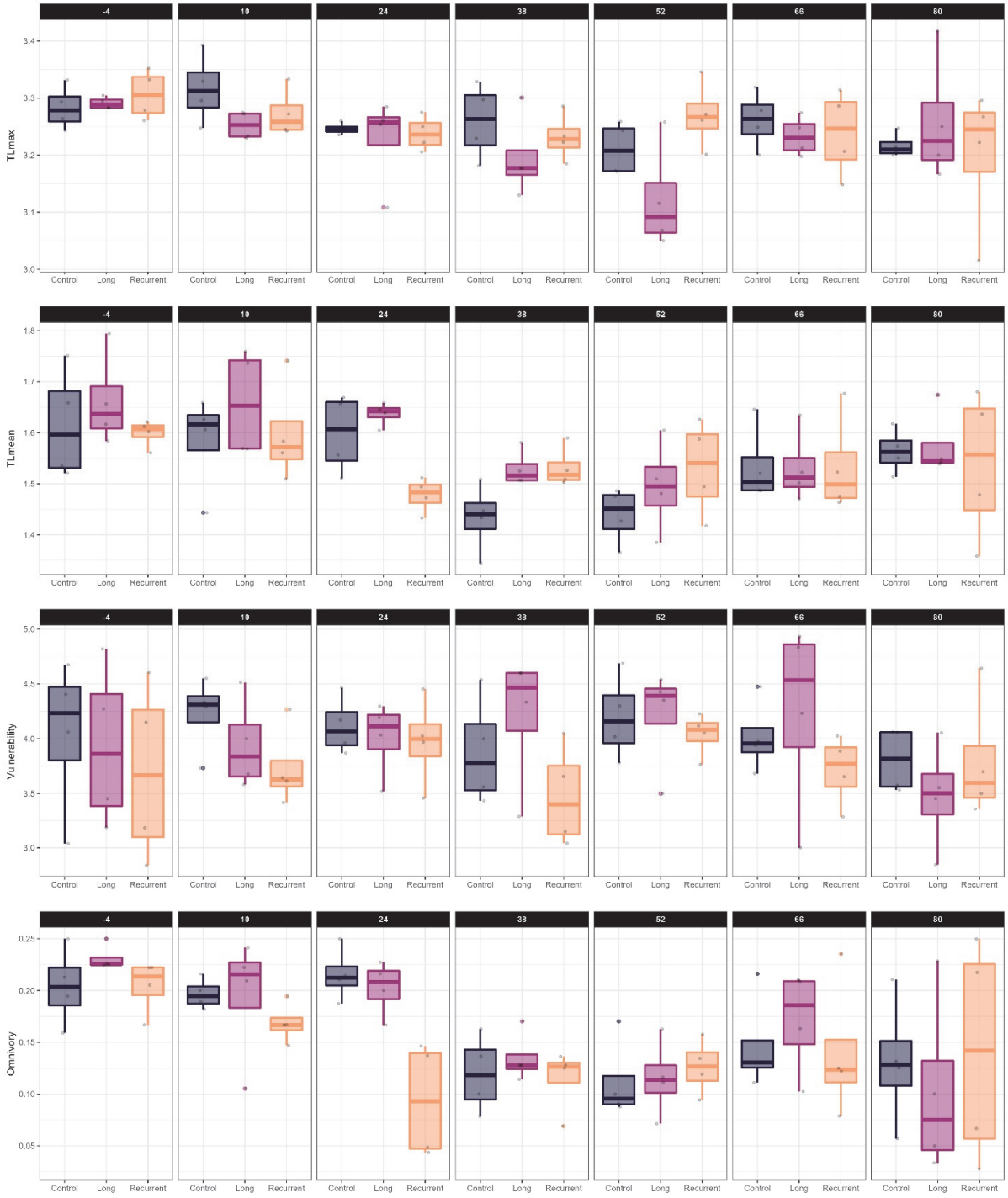

Fig. S8. Box and whisker plots ($n = 4$, for all measures) showing the responses of (from top panel to bottom panel) maximum trophic level, mean trophic level, vulnerability, and omnivory (all unweighted/topological properties of the networks) in the different phases of the experiment. For all box and whisker plots, the centre line indicates the median, while the bottom and top hinges of the box correspond to the 25th and 75th percentiles, respectively.

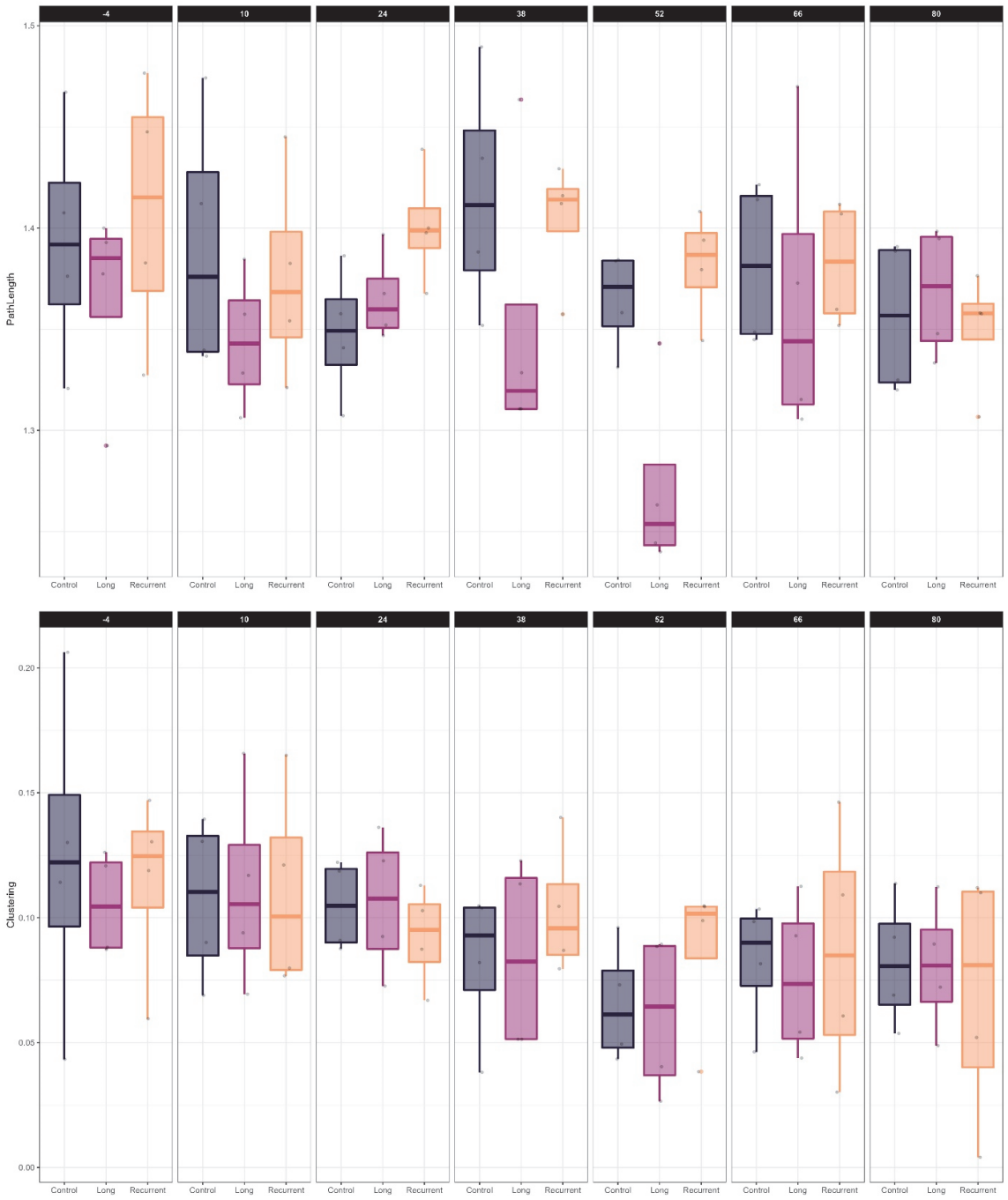

Fig. S9. Box and whisker plots ($n = 4$, for all measures) showing the responses of (from top panel to bottom panel) path length, and clustering (all unweighted/topological properties of the networks) in the different phases of the experiment. For all box and whisker plots, the centre line indicates the median, while the bottom and top hinges of the box correspond to the 25th and 75th percentiles, respectively.

References

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