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Supplementary Materials for

A general pattern of trade-offs between ecosystem resistance and resilience to tropical cyclones

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The PDF file includes:

Supplementary text
Figs. S1 to S4
Tables S1 to S4
Legends for data S1 and S2
Legends for codes S1 and S2

Other Supplementary Material for this manuscript includes the following:

Data S1 and S2
Codes S1 and S2

Simulation Model

Observed resistance and resilience are calculated from different aspects of the temporal trajectory of an ecosystem response variable following a disturbance event (Fig. S1). The resistance equation includes the effect size of the response and the magnitude of the stressor, whereas the resilience equation includes the effect size of the response and the time until the variable returns to baseline conditions (see methods). The resistance equation is multiplied by -1 to flip the axis and make it conform to an intuitive directionality: low resistance = low metric value. Given the shared numerator of these two equations and the flipped axis on the resistance equation, there is a bias for these two metrics to be negatively related to one another

To evaluate the degree to which the formulas for observed resistance and resilience influences the relationship between these variables, independent of the biological processes of interest, we developed a series of simulation models and compared these models to each other and to our data. We designed one set of simulation models to be based on the processes in our *a priori* conceptional model of how intrinsic resistance and resilience drive ecosystem response to a disturbance. We used these models to evaluate how different relationships between intrinsic resistance and resilience affect observed resistance and resilience when the system works as we predict. For our second set of simulation models, we compared our observed patterns in the data to different null models of simulated random data to determine whether our dataset could have been the product of random chance. We explain each set of simulations, the results, and our interpretation of the results in the following sections.

Process Based Simulations

Our conceptual model states that each variable of interest has an intrinsic resistance and resilience that is dictated by characteristics such as functional traits for organisms or the degree of biological control for ecosystem processes. We predict that the maximum change measured in a variable following a disturbance is positively related to stressor magnitude, but that the slope of that relationship declines with increasing intrinsic resistance (Fig S2A). Similarly, the time until a variable returns to its baseline condition is positively related to the magnitude of the response following the disturbance, but the slope of that relationship declines with increasing resilience (Fig S2B). Observed resistance and resilience serve as indicators of intrinsic resistance and resilience and are calculated from stressor intensity, maximum change following disturbance, and the return time to baseline (Fig S2C).

We had three sets of models designed to simulate the process in the aforementioned conceptual model. In each model we set either a positive, negative, or no relationship between intrinsic resistance and resilience. Each set of models consisted of simulating 500 datasets each with 1000 time series (n=1500 datasets, 1.5-million-time series). For each dataset, we started by generating 1000 random stressor values from a uniform distribution from 30 to 300 (approximating the distribution of the rainfall data), 1000 intrinsic resilience values drawn randomly from a uniform distribution from 1 to 100, and 1000 pre-storm values drawn randomly from a uniform distribution from 70 to 130. In simulations with no relationship between intrinsic resistance and resilience, intrinsic resistance values were also drawn randomly from a uniform distribution from 1 to 100. In simulations with a positive relationship between intrinsic resistance and resilience, we calculated resistance by taking the corresponding resilience value and added a random number drawn from a uniform distribution from -5 to 5 to add random noise. Lastly, for simulations with a negative relationship between intrinsic resistance and resilience, we calculated resistance as 100 minus the corresponding resilience value and adding a random number drawn from a uniform distribution from -5 to 5 to add random noise. For each observation *i* in each dataset, the maximum observed change ($max\ \Delta_i$) was calculated as:

$$max\ \Delta_i = \frac{Str_i * B_i}{IRt_i} + B_i + \varepsilon$$

Where *Str* is stressor intensity, *B* is baseline value, *IRt* is intrinsic resistance, and ε is a random number drawn from a uniform distribution from -20 to 20. For each observation *i* in each dataset, the return time to baseline (*RT*) was calculated as:

$$RT_i = \left(\frac{max\Delta_i - B_i}{B_i}\right) * \left(1 - \frac{IRl_i}{100}\right) + \varepsilon$$

Where *IRl* is the intrinsic resilience. The natural log response ration (*LRR*), observed resistance (*ORt*), and resilience (*ORl*) were all calculated from these values using the equations in the main text (see methods). For each simulated dataset of 1000 values, we fit a simple linear regression between observed resistance and resilience and saved the *p*-value, slope, and R^2 value of the relationship (n=500 fitted regression models per set of simulations).

Randomization Simulations

To test if the patterns we found were due to our formula choice, we ran three different sets of simulations with randomly generated observations. Each set of models consisted of simulating 500 datasets each with 1000 time series (n=1500 datasets, 1.5-million time series). In all three sets of simulations we randomly generated the baseline value, stressor value, maximum proportional change, and return time for each time series. We then calculated *LRR*, *ORt*, and *ORl* using the equations in the main text. For the first set of simulations, we drew all of the random values from uniform distributions. In the second set of simulations, we randomly selected the values for baseline, stressor, maximum proportional change, and return time from the observations in our dataset; we performed the random selection process separately for each variable. For the third set of simulations, we randomly selected values from our dataset, however, the stressor and maximum proportional change values were drawn from the same observation; all other variables were selected independently. This third version of the model preserved the likely link between stressor intensity and response magnitude while breaking any non-random association between response magnitude and return time. For each simulated dataset of 1000 values, we fit a simple linear regression between observed resistance and observed resilience and saved the *p*-value, slope, and R^2 value of the relationship (n=500 fitted regression models per set of simulations).

We compared the parameters from the null models to the parameters from a simple linear regression model fit to the entire observed dataset as well as regressions fit to random subsets of the data to consider the effect of potential outliers on the shape of the relationship in our data. Following a similar approach to the simulations, we randomly selected 500 observations without replacement from our dataset 500 times and fit a regression model to each random subset. The distributions of the model coefficients and goodness of fit metrics from the subsets of the dataset were compared to the distributions obtained from the simulations.

Results

Process Based Simulations

The relationship between observed resistance and resilience was different for each of the three process-based simulations. The version with no relationship between intrinsic resistance and resilience generated slightly positive observed relationships on average (slope: 0.026 ± 0.017 SD), explained very little variation (R^2: 0.002 ± 0.003 SD), and most outcomes were not statistically significant (65.8% had *p*-value > 0.05). For the simulations with a positive relationship between intrinsic resistance and resilience, relationships between observed resistance and resilience were all positive (slope: 0.322 ± 0.015 SD), explained 0.299 ± 0.019 SD variation, and were all statistically significant at an α of 0.05. Lastly, the simulations that had a negative relationship between intrinsic resistance and resilience generated negative relationships between observed resistance and resilience (slope: -0.709 ± 0.019 SD), which explained 0.732 ± 0.017 SD of the variation, and were all statistically significant at an α of 0.05.

In conclusion, the process-based simulations demonstrate two important points. First, despite the bias toward a negative relationship between observed resistance and resilience in our equations, it is not a forgone conclusion that these metrics are negatively related in nature. Our process-based simulations showed that the relationship between observed resistance and resilience could be positive, negative, or nonexistent (Fig. S3). Secondly, the simulation demonstrates that if our conceptual model (Fig. S2) accurately represents natural, biological processes, then the relationship between observed resistance and resilience that we measure is indicative of the relationship between intrinsic resistance and intrinsic resilience.

Random Simulations

The random simulations all produced negative relationships between observed resistance and resilience (Fig. S4), however, all outputs were significantly different from our observed relationships in terms of slope (observed dataset slope: -0.375) and variation explained (observed dataset R^2: 0.429) by the linear regression model. The simulations that used randomly generated data had a very poor fit, exhibiting a mean slope of -0.075 ± 0.025 SD and a mean R^2 value of 0.010 ± 0.007 SD (Fig. S4). The models based on random draws from our observed data had better fits but still had significantly shallow slopes (all random: -0.246 ± 0.020 SD, partial random: -0.245 ± 0.019 SD) as well as lower explanatory power than the observed data (all random: 0.134 ± 0.029 SD, partial random: 0.130 ± 0.027 SD).

The random simulations demonstrate that in a completely random world, there is, as we expected, a bias toward negatively relationships between observed resistance and resilience. However, it is extremely unlikely that the relationships in our dataset were produced by this alone. First, the completely random simulation (Fig. 4, Row 1) suggests that the bias toward negatively relationships with completely random data may be very subtle in terms of slope and explanatory power. Second, in a direct test of the alternate hypothesis that patterns in our dataset were generated by chance, we found that the simulated data failed to capture the shape of the relationship between observed resistance and resilience. The simulations which drew random values from our observed data explained roughly 30% less variation (observed data: 42.9% vs. randomized data: 13.4%) and the slopes were significantly shallower than what we observed (observed data: -0.375 vs. randomized data: -0.245). This latter comparison may also be very conservative. The data we randomized in the second and third simulations were, in all likelihood, created by biologically important processes and so the distributions we drew from had a higher chance of reproducing the observed patterns than completely randomly generated observations.

Conclusions

We interpret the results of the simulations to indicate that a variety of relationships between observed resistance and observed resilience are possible and that the patterns in our data could not have been generated solely by random chance and must have been the result of deterministic processes. We use this premise as justification to use standard statistical tools to quantify the relationships and attempt to infer process from the observed patterns.

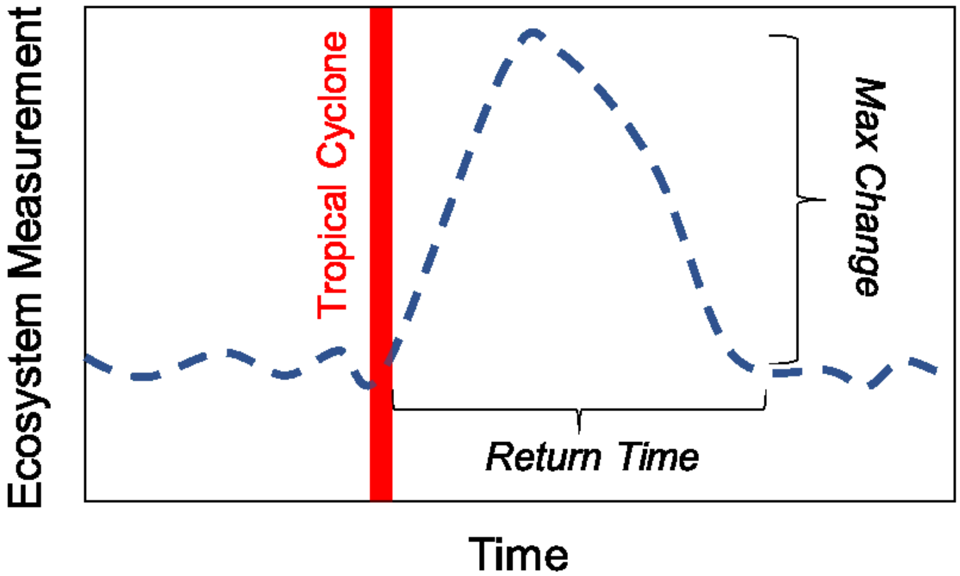

Fig. S1. Simple diagram showing the temporal trajectory of a measured variable before, during, and after a hurricane disturbance. Two of the key variables we use to measure observed resistance (effect size) and resilience (return time, effect size) are labeled in the diagram. Figure was modified from Hogan et al. 2020 with permission from the American Institute of Biological Sciences and Oxford University Press (*8*).

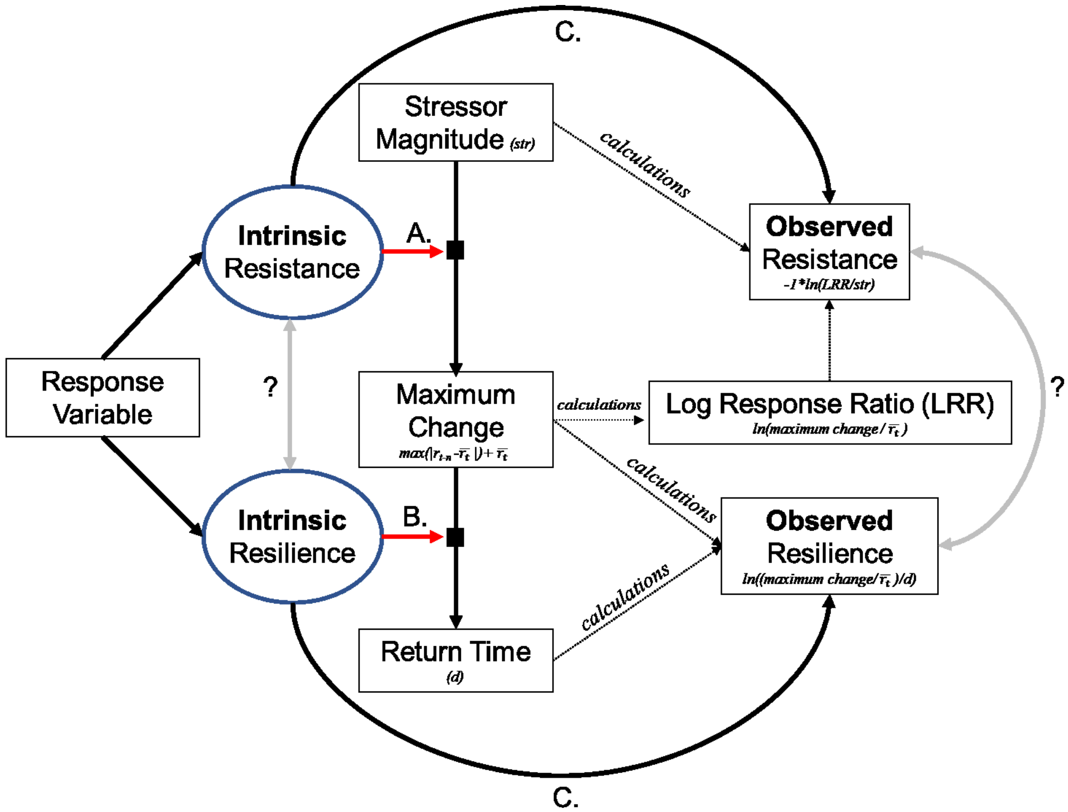

Fig. S2. Conceptual model of how the latent variables, intrinsic resistance and intrinsic resilience, influence the effect of stressor magnitude on maximum change and maximum change on return time. The diagram also shows how log response ratio, observed resistance, and observed resilience are calculated from the observations of stressor magnitude, maximum change, and return time. The conceptual model treats observed resistance and resilience as measurable indicators of the latent variable's intrinsic resistance and resilience.

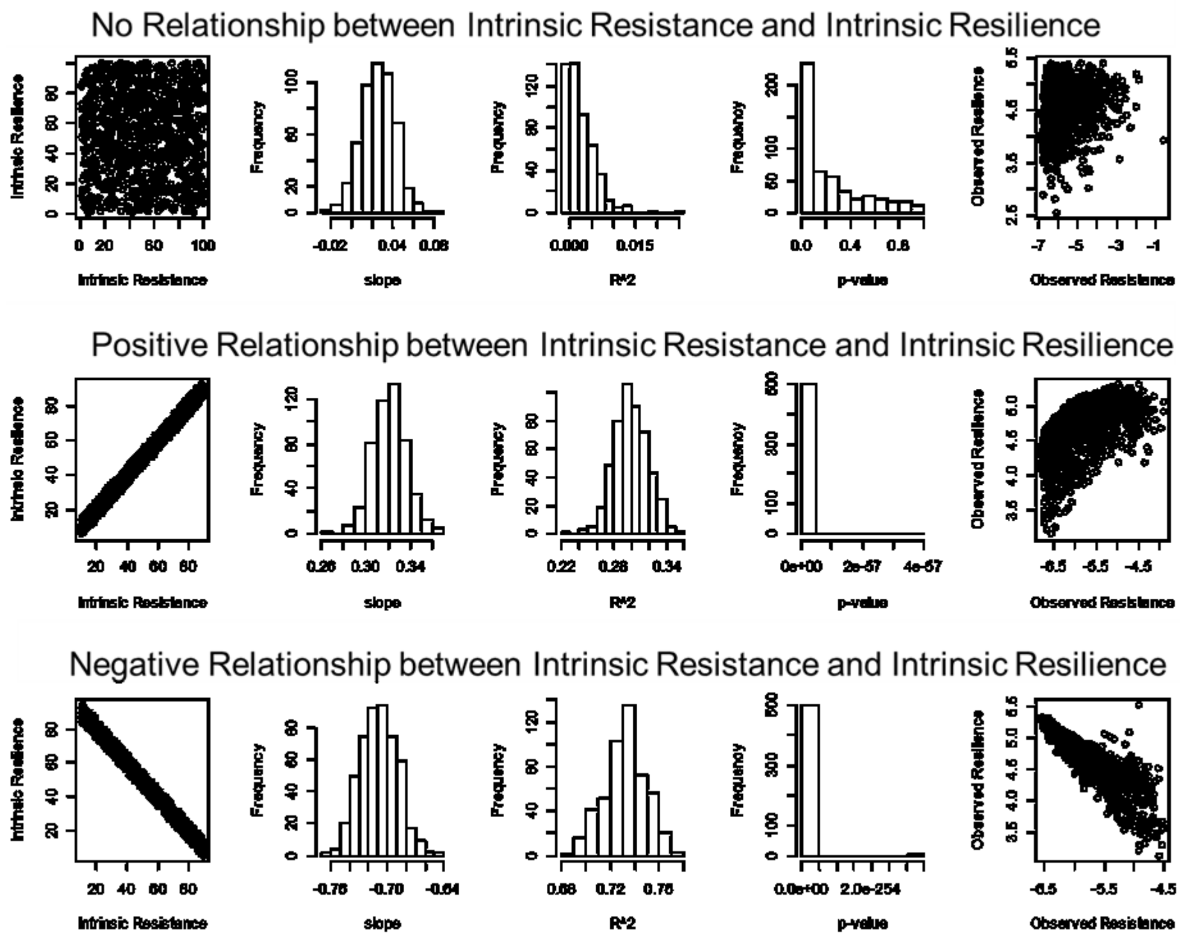

Fig. S3. Summarized results of process-based simulation models. Columns show different outputs from the three types of simulations (rows). Outer columns show example relationships between intrinsic resistance and intrinsic resilience (left) and observed resistance and resilience (right). The center three columns are distributions of fitted model parameters (slope, R^2, *p*-value) across all simulations for each set.

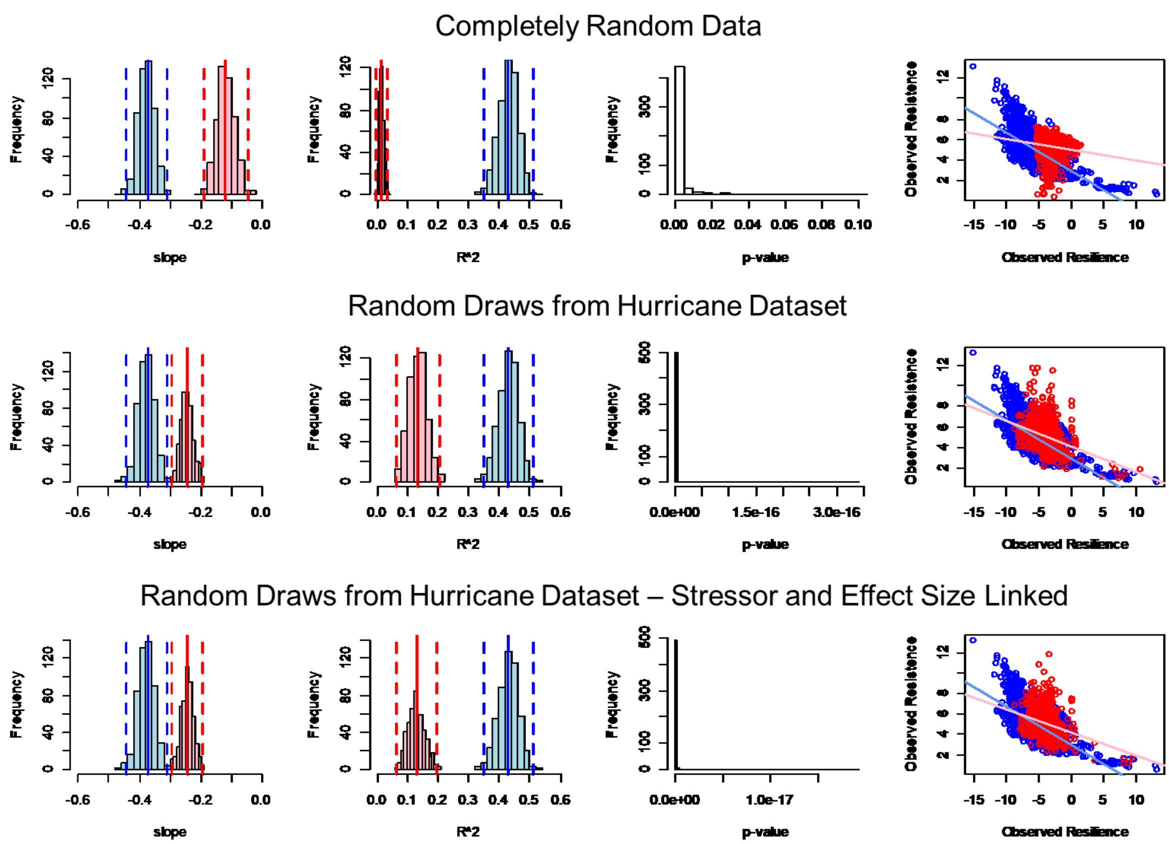

Figure S4. Summarized results of randomized simulation models. Each row corresponds to a different set of models. The columns show different outputs from the simulations. In each graph, blue denotes our dataset and red denotes randomized data. In the histograms, solid lines are means and dotted lines are the 95% confidence intervals. From left to right, columns 1-3 display distributions of model parameters (slope, R^2, *p*-value) from across simulation runs. The right column shows the relationship between observed resistance and resilience for the observed dataset (blue points) and for one example of the randomized data (red points). The lines in the scatterplots are best fit lines (light blue = observed data, pink = randomized data).

Table S1.

Mixed Effects Model Significance Tests. Each row corresponds to a model to fit to the entire dataset with the response and fixed effect corresponding to the response and predictor columns. For the first two rows, variable category within ecosystem type was treated as a random intercept effect (reported in Table S2). For the remaining rows corresponding to models linking ecosystem sensitivity to stressor intensity, variable category was treated as a random slope effect (reported in Table S2).

Response	**Predictor**	**DF**	**F**	***P*-value**	**Marginal R^2**	**Conditional R^2**
ln(Resistance to Wind Speed)	Resilience	1,10.244	48.787	< 0.001	0.493	0.672
ln(Resistance to Rainfall)	Resilience	1,9.745	22.731	< 0.001	0.389	0.657
Resilience	Max Wind	1,5.180	0.282	0.617	0.012	0.276
Resilience	Max Rain	1,3.270	0.012	0.923	0.002	0.291
Resilience	Total Rain	1,3.045	0.207	0.680	0.002	0.291
Resistance to Wind Speed	Max Wind	1, 5.862	18.599	0.005	0.051	0.197
Resistance to Rainfall	Max Rain	1, 7.212	24.384	0.002	0.189	0.365
Resistance to Rainfall	Total Rain	1,8.608	24.426	< 0.001	0.170	0.337

Table S2.

Mixed Effects Model Coefficients. For all models referenced in Table S1, the corresponding model coefficients including fixed intercept, fixed slope, random intercept, and where applicable, random slope are reported here as well as the categorical groupings (ecosystem type, variable category) to which these coefficients correspond.

Response	Predictor	Fixed Intercept	Fixed Slope	System	Variable Category	Random Intercept	Random Slope
ln(Resistance to Wind Speed)	Resilience	1.089	-0.095	Freshwater	Biogeochemistry	1.534	-0.003
				Freshwater	Hydrography	1.304	-0.081
				Freshwater	Mobile Biota	0.864	-0.146
				Saline	Biogeochemistry	1.039	-0.101
				Saline	Hydrography	1.165	-0.068
				Saline	Mobile Biota	1.173	-0.078
				Saline	Sedentary Fauna	0.943	-0.122
				Saline	Vascular Plant	0.787	-0.165
				Terrestrial	Biogeochemistry	0.950	-0.114
				Terrestrial	Hydrography	1.026	-0.113
				Terrestrial	Vascular Plant	1.265	-0.059
				Wetland	Mobile Biota	1.039	-0.094
				Wetland	Vascular Plant	1.061	-0.096
				-	Biogeochemistry	1.063	-0.096
				-	Hydrography	1.132	-0.094
				-	Mobile Biota	1.074	-0.096
				-	Sedentary Fauna	1.082	-0.096
				-	Vascular Plant	1.092	-0.095
ln(Resistance to Rainfall)	Resilience	1.397	-0.076	Freshwater	Biogeochemistry	1.783	0.009
				Freshwater	Hydrography	1.712	-0.037
				Freshwater	Mobile Biota	1.187	-0.130
				Saline	Biogeochemistry	1.426	-0.070
				Saline	Hydrography	1.544	-0.047
				Saline	Mobile Biota	1.130	-0.104
				Saline	Sedentary Fauna	1.200	-0.115
				Saline	Vascular Plant	0.989	-0.158
				Terrestrial	Biogeochemistry	1.223	-0.101
				Terrestrial	Hydrography	1.285	-0.105
				Terrestrial	Vascular Plant	1.751	0.004
				Wetland	Mobile Biota	1.593	-0.050
				Wetland	Vascular Plant	1.343	-0.083
				-	Biogeochemistry	1.395	-0.076
				-	Hydrography	1.402	-0.076
				-	Mobile Biota	1.397	-0.076
				-	Sedentary Fauna	1.397	-0.076
				-	Vascular Plant	1.395	-0.076
Resilience	Max Wind	-4.331	-0.227	Freshwater	Biogeochemistry	-4.007	0.021
				Freshwater	Hydrography	-1.405	-0.492
				Freshwater	Mobile Biota	-4.686	-0.087
				Saline	Biogeochemistry	-4.779	-0.173
				Saline	Hydrography	-5.622	-0.023
				Saline	Mobile Biota	-5.073	0.115
				Saline	Sedentary Fauna	-4.665	-0.218
				Saline	Vascular Plant	-3.028	-0.465
				Terrestrial	Biogeochemistry	-7.941	0.055
				Terrestrial	Hydrography	-4.355	-0.314
				Terrestrial	Vascular Plant	-3.881	-0.262
				Wetland	Mobile Biota	-1.322	-1.017
				Wetland	Vascular Plant	-5.535	-0.095
Resilience	Max Rain	-4.915	-0.048	Freshwater	Biogeochemistry	-4.831	0.191
				Freshwater	Hydrography	-4.370	0.170
				Freshwater	Mobile Biota	-5.406	0.019

				Saline	Biogeochemistry	-5.403	0.083
				Saline	Hydrography	-5.913	0.097
				Saline	Mobile Biota	-5.021	-0.018
				Saline	Sedentary Fauna	-5.224	-0.060
				Saline	Vascular Plant	-3.793	-0.394
				Terrestrial	Biogeochemistry	-5.629	-0.313
				Terrestrial	Hydrography	-5.009	-0.153
				Terrestrial	Vascular Plant	-5.476	0.150
				Wetland	Mobile Biota	-2.293	-0.315
				Wetland	Vascular Plant	-5.529	-0.080
Resilience	Total Rain	-5.046	-0.041	Freshwater	Biogeochemistry	-4.558	0.158
				Freshwater	Hydrography	-4.465	0.193
				Freshwater	Mobile Biota	-5.344	0.021
				Saline	Biogeochemistry	-5.608	0.113
				Saline	Hydrography	-5.912	0.087
				Saline	Mobile Biota	-4.885	-0.042
				Saline	Sedentary Fauna	-5.280	-0.063
				Saline	Vascular Plant	-4.062	-0.346
				Terrestrial	Biogeochemistry	-5.836	-0.334
				Terrestrial	Hydrography	-5.057	-0.153
				Terrestrial	Vascular Plant	-5.609	0.163
				Wetland	Mobile Biota	-3.095	-0.324
				Wetland	Vascular Plant	-5.891	-0.008
Resistance to Wind Speed	Max Wind	4.052	0.252	Freshwater	Biogeochemistry	3.269	0.291
				Freshwater	Hydrography	4.509	0.170
				Freshwater	Mobile Biota	4.010	0.238
				Saline	Biogeochemistry	3.923	0.293
				Saline	Hydrography	3.757	0.361
				Saline	Mobile Biota	3.862	0.188
				Saline	Sedentary Fauna	4.083	0.235
				Saline	Vascular Plant	3.202	0.471
				Terrestrial	Biogeochemistry	5.467	0.153
				Terrestrial	Hydrography	4.103	0.297
				Terrestrial	Vascular Plant	3.927	0.241
				Wetland	Mobile Biota	3.680	0.263
				Wetland	Vascular Plant	4.879	0.075
Resistance to Rainfall	Max Rain	5.031	0.253	Freshwater	Biogeochemistry	4.496	0.230
				Freshwater	Hydrography	5.553	0.165
				Freshwater	Mobile Biota	5.018	0.217
				Saline	Biogeochemistry	5.744	0.111
				Saline	Hydrography	5.643	0.149
				Saline	Mobile Biota	4.044	0.353
				Saline	Sedentary Fauna	4.931	0.204
				Saline	Vascular Plant	3.835	0.656
				Terrestrial	Biogeochemistry	5.472	0.335
				Terrestrial	Hydrography	4.848	0.345
				Terrestrial	Vascular Plant	4.893	0.242
				Wetland	Mobile Biota	5.743	0.071
				Wetland	Vascular Plant	5.183	0.214
Resistance to Rainfall	Total Rain	5.195	0.241	Freshwater	Biogeochemistry	4.641	0.240
				Freshwater	Hydrography	5.608	0.170
				Freshwater	Mobile Biota	5.117	0.219
				Saline	Biogeochemistry	5.882	0.082
				Saline	Hydrography	5.720	0.139
				Saline	Mobile Biota	3.991	0.424
				Saline	Sedentary Fauna	4.902	0.242
				Saline	Vascular Plant	4.399	0.558
				Terrestrial	Biogeochemistry	5.761	0.336
				Terrestrial	Hydrography	5.080	0.302

				Terrestrial	Vascular Plant	5.219	0.145
				Wetland	Mobile Biota	5.378	0.169
				Wetland	Vascular Plant	5.841	0.110

Table S3.

Output from ANOVA models testing whether ecosystem sensitivity metrics vary significantly among variable categories and system categories. Post-hoc comparison tests are reported in Table S4. * indicates significant at an adjusted α of 0.006

Response	Predictor	Sum of Squares	DF	F	*p*-value
Resilience	Biogeochemistry across Systems	704.743	2	69.306	< 0.001*
	Residuals	13005.545	2558		
Resilience	Hydrography across Systems	266.285	2	44.339	< 0.001*
	Residuals	3645.404	1214		
Resilience	Mobile Biota across Systems	9.457	2	0.497	0.609
	Residuals	1903.520	200		
Resilience	Vascular Plant across Systems	10.081	2	2.452	0.090
	Residuals	283.726	138		
Resistance to Wind Speed	Biogeochemistry across Systems	124.999	2	35.234	< 0.001*
	Residuals	4537.536	2558		
Resistance to Wind Speed	Hydrography across Systems	11.052	2	4.714	0.009
	Residuals	1423.265	1214		
Resistance to Wind Speed	Mobile Biota across Systems	7.252	2	3.048	0.050
	Residuals	237.920	200		
Resistance to Wind Speed	Vascular Plant across Systems	4.243	2	1.702	0.186
	Residuals	171.955	138		
Resistance to Rainfall	Biogeochemistry across Systems	145.135	2	42.352	< 0.001*
	Residuals	4382.938	2558		
Resistance to Rainfall	Hydrography across Systems	12.517	2	5.285	0.005*
	Residuals	1437.573	1214		
Resistance to Rainfall	Mobile Biota across Systems	54.876	2	14.561	< 0.001*
	Residuals	376.878	200		
Resistance to Rainfall	Vascular Plant across Systems	4.963	2	1.474	0.233
	Residuals	232.367	138		
Resilience	Freshwater across Variables	65.535	2	8.281	< 0.001*
	Residuals	910.142	230		
Resilience	Saline across Variables	168.320	4	9.167	< 0.001*
	Residuals	16699.022	3638		
Resilience	Terrestrial across Variables	26.337	2	4.723	0.012
	Residuals	192.401	69		
Resilience	Wetland across Variables	96.922	1	17.232	< 0.001*
	Residuals	1057.390	188		
Resistance to Wind Speed	Freshwater across Variables	14.224	2	8.088	< 0.001*
	Residuals	202.238	230		
Resistance to Wind Speed	Saline across Variables	20.441	4	3.175	0.013
	Residuals	5854.516	3638		
Resistance to Wind Speed	Terrestrial across Variables	7.076	2	1.707	0.189
	Residuals	143.053	69		
Resistance to Wind Speed	Wetland across Variables	28.680	1	28.717	< 0.001*

	Residuals	187.752	188		
Resistance to Rainfall	Freshwater across Variables	22.439	2	10.091	< 0.001*
	Residuals	255.724	230		
Resistance to Rainfall	Saline across Variables	79.228	4	12.394	< 0.001*
	Residuals	5814.140	3638		
Resistance to Rainfall	Terrestrial across Variables	17.228	2	3.881	0.025
	Residuals	153.133	69		
Resistance to Rainfall	Wetland across Variables	0.574	1	0.456	0.501
	Residuals	236.716	188		

Table S4.

Results of post-hoc TukeyHSD tests on significant ANOVA models of differences in ecosystem sensitivity among variable categories within ecosystem types and among ecosystem types within variables.

Response	Classification	Dataset	Comparison	Difference	SE	DF	t-ratio	*p*-value
Resilience	Ecosystem	Biogeochemistry across Systems	Freshwater - Saline	1.525	0.199	2558	7.667	< 0.001
			Freshwater - Terrestrial	3.954	0.338	2558	11.689	< 0.001
			Saline - Terrestrial	2.429	0.281	2558	8.632	< 0.001
		Hydrography across Systems	Freshwater - Saline	2.271	0.243	1214	9.331	< 0.001
			Freshwater - Terrestrial	3.444	1.028	1214	3.349	0.002
			Saline - Terrestrial	1.173	1.002	1214	1.171	0.471
Resistance to Wind Speed	Ecosystem	Biogeochemistry across Systems	Freshwater - Saline	-0.286	0.117	2558	-2.438	0.039
			Freshwater - Terrestrial	-1.605	0.200	2558	-8.033	< 0.001
			Saline - Terrestrial	-1.319	0.166	2558	-7.933	< 0.001
Resistance to Rainfall	Ecosystem	Biogeochemistry across Systems	Freshwater - Saline	-0.363	0.115	2558	-3.145	0.005
			Freshwater - Terrestrial	-1.755	0.196	2558	-8.938	< 0.001
			Saline - Terrestrial	-1.392	0.163	2558	-8.522	< 0.001
		Hydrography across Systems	Freshwater - Saline	0.269	0.153	1214	1.760	0.184
			Freshwater - Terrestrial	-1.462	0.646	1214	-2.264	0.061
			Saline - Terrestrial	-1.731	0.629	1214	-2.752	0.017
		Mobile Biota across Systems	Freshwater - Saline	1.104	0.254	200	4.349	< 0.001
			Freshwater - Wetland	0.090	0.263	200	0.342	0.937
			Saline - Wetland	-1.014	0.219	200	-4.638	< 0.001
Resilience	Variable Category	Freshwater across Variables	Biogeochemistry - Hydrography	-0.432	0.322	230	-1.342	0.374
			Biogeochemistry - Mobile Biota	1.158	0.345	230	3.357	0.003
			Hydrography - Mobile Biota	1.590	0.406	230	3.920	< 0.001
		Saline across Variables	Biogeochemistry - Hydrography	0.314	0.077	3638	4.091	< 0.001
			Biogeochemistry - Mobile Biota	-0.920	0.234	3638	-3.933	0.001
			Biogeochemistry - Sedentary Fauna	0.467	0.537	3638	0.870	0.908
			Biogeochemistry - Vascular Plant	-0.005	0.481	3638	-0.011	1.000
			Hydrography - Mobile Biota	-1.234	0.238	3638	-5.182	< 0.001
			Hydrography - Sedentary Fauna	0.153	0.539	3638	0.284	0.999
			Hydrography - Vascular Plant	-0.320	0.483	3638	-0.662	0.964
			Mobile Biota - Sedentary Fauna	1.387	0.583	3638	2.380	0.121
			Mobile Biota - Vascular Plant	0.914	0.531	3638	1.721	0.421
			Sedentary Fauna - Vascular Plant	-0.473	0.719	3638	-0.658	0.965
		Wetland across Variables	Mobile Biota - Vascular Plant	1.472	0.355	188	4.151	< 0.001
Resistance to Wind Speed	Variable Category	Freshwater across Variables	Biogeochemistry - Hydrography	-0.602	0.152	230	-3.963	< 0.001
			Biogeochemistry - Mobile Biota	-0.277	0.163	230	-1.702	0.207
			Hydrography - Mobile Biota	0.325	0.191	230	1.699	0.208
		Wetland across Variables	Mobile Biota - Vascular Plant	-0.801	0.149	188	-5.359	< 0.001
Resistance to Rainfall	Variable Category	Freshwater across Variables	Biogeochemistry - Hydrography	-0.676	0.171	230	-3.960	< 0.001
			Biogeochemistry - Mobile Biota	-0.564	0.183	230	-3.084	0.006
			Hydrography - Mobile Biota	0.112	0.215	230	0.522	0.861
		Saline across Variables	Biogeochemistry - Hydrography	-0.044	0.045	3638	-0.974	0.867
			Biogeochemistry - Mobile Biota	0.903	0.138	3638	6.546	< 0.001
			Biogeochemistry - Sedentary Fauna	-0.455	0.317	3638	-1.435	0.605
			Biogeochemistry - Vascular Plant	-0.367	0.284	3638	-1.292	0.696
			Hydrography - Mobile Biota	0.948	0.141	3638	6.743	< 0.001
			Hydrography - Sedentary Fauna	-0.411	0.318	3638	-1.291	0.697
			Hydrography - Vascular Plant	-0.323	0.285	3638	-1.131	0.790
			Mobile Biota - Sedentary Fauna	-1.358	0.344	3638	-3.950	0.001
			Mobile Biota - Vascular Plant	-1.270	0.313	3638	-4.052	< 0.001
			Sedentary Fauna - Vascular Plant	0.088	0.424	3638	0.208	1.000

Data S1. (separate file)

Excel document with the hurricane response data and meta-data describing variable names

Data S2. (separate file)

CSV document with the hurricane response data used in the analyses

Code S1. (separate file)

R script with the code for reproducing analyses reported in the main text and the figures

Code S2. (separate file)

R script with the code for reproducing the simulation model analyses and figures reported in the supplement