

## **Supplementary Information**

### **S1 Appendix. Literature Review Citations for Table 1**

Published studies that examined change in fish abundances before and after hurricanes listed in the literature review.

### **S1 Figure. Statistical Analysis Flowchart and Transformations**

Decision-tree indicating how fish data was subsetted, transformed, and analyzed. If not listed as transformed, raw data was used as the response variable.

### **S1 Table. Seagrass meadow locations and survey dates**

Meadows surveyed for both fishes and percent cover of seagrass. Seagrass survey dates (month/year) and periodicity listed.

### **S2 Table. Temperature and Salinity ANOVA summary statistics**

Summary results examining potential correlations between environmental variables, namely surface water temperature and salinity, fish catches and species richness.

### **S3 Table. Short-term ANOVA summary statistics**

Summary results of short-term ANOVA tests across time period (before vs. after) and year type (control vs. impact year) for mBACI and Arthur BACI. Short-term analyses include only trawls conducted within 23 days of stormfall. Response variables were transformed when necessary to meet assumptions of parametric statistics. Post-hoc test results are not presented as no interaction term was significant.

### **S4 Table. Mean fish metrics across mBACI treatments**

Mean +/- standard error CPUE, CPUE-Lr, and species richness for multi-storm mBACI and BACI comparisons. Percent change is calculated as the decline or increase in catch or richness between before and after periods:  $\frac{\text{before} - \text{after}}{\text{before}} \times 100$ . **Note:** Means presented are rounded to whole values for catch and one decimal place for species richness. Percent change was calculated using unrounded values and may differ from calculations based upon means in the table.

### **S5 Table. NMDS environmental correlates**

Summary results of environmental variables tested for potential correlation with fish community structure at the short-term and seasonal time frames.

### **S6 Table. Contributing species to group dissimilarities**

Results of Similarity Percentages (SIMPER) analysis indicating the species that contribute the most to dissimilarity across BACI groups based on Bray-Curtis dissimilarities calculated from fourth-root transformed abundance data. Only the top 10 species that contribute the most to between-group dissimilarities are listed.

### **S7 Table. Seasonal ANOVA and Tukey HSD for mBACI, Arthur- and Matthew BACIs**

Summary results of seasonal-scale ANOVA tests across time period (before vs. after) and year type (control vs. impact year). Seasonal analyses include trawls conducted during the months of

May-October. Response variables were transformed when necessary to meet assumptions of parametric statistics. Post-hoc test results are presented when the interaction term is significant at  $p < 0.05$ . Abbreviations indicate treatments; CB = control before, IB = impact before, CA = control after, IA = impact after

### **S8 Table. GAM Summary Statistics for Seasonal mBACI**

All generalized additive models (GAMs) were run for the seasonal time frame against days since storm as the independent variable and built using a cubic regression spline with penalized shrinkage, a maximum of three degrees of freedom, negative binomial error distribution with log link function, and restricted maximum likelihood smoothing parameter. edf = effective degrees of freedom, logLik = log likelihood, Dev = deviance, df.r = residual degrees of freedom, AIC = Akaike information criterion BIC = Bayesian information criterion.

### **S9 Table. Hurricane Arthur GLM Summary Statistics**

Negative binomial generalized linear models for seasonal-scale trend analysis of Hurricane Arthur (2014) versus 2015 as the control year. Est = estimate, df.r = residual degrees of freedom, AIC = Akaike information criterion BIC = Bayesian information criterion.

### **S2 Figure. Individual mBACI treatment PCoA ordinations of short-term communities**

This figure demonstrates the potential difference/lack of difference in short-term community dispersion within each mBACI treatment using Principle Coordinates Analysis. Convex hulls are drawn in dashed lines through the outer-most points.

### **S3 Figure. Individual mBACI group PCoA ordinations of seasonal communities**

This figure demonstrates the potential difference/lack of difference in seasonal community dispersion within each mBACI treatment using Principle Coordinates Analysis. Convex hulls are drawn in dashed lines through the outer-most points.

### **S4 Figure. Hurricane Arthur BACI comparisons**

Short-term and seasonal fish catches and species richness across time periods (before vs. after) and year type (control vs. impact) for Hurricane Arthur (July 2014) compared to 2015 (control year). Only means are presented for short-term comparisons (column 1); whereas means, trend, and difference between control and impact trends (columns 2-4, respectively) are depicted for seasonal comparisons. Catch per unit effort (CPUE) is presented in row 1 (A, D, H, K); CPUE calculated sans *L. rhomboides* is presented in row 2 (B, E, I, L), and species richness is row 3 (C, F, J, M). P-values indicate the significance of the interactive ANOVA term. Error bars represent standard error. Smoothed lines represent generalized additive models ( $y \sim s(\text{Days to Storm}), k = 3$ ) for both hurricane and storm-free years based on a cubic regression spline with shrinkage and 95% confidence intervals.

### **S5 Figure. Hurricane Matthew Seasonal BACI comparisons**

Seasonal fish catch per unit effort (A), catch per unit effort sans *Lagodon rhomboides* (B) and species richness (C) across time periods (before vs. after) and year type (control vs. impact) for Hurricane Matthew (October 2016) compared to 2017 (control year). Only means are presented for seasonal comparisons (column 1), as the closest trawl samples prior to hurricane Matthew occurred outside of the short-term window and all trawls that occurred after the storm were

conducted on the same day. P-values indicate the significance of the interactive ANOVA term. Error bars represent standard error.

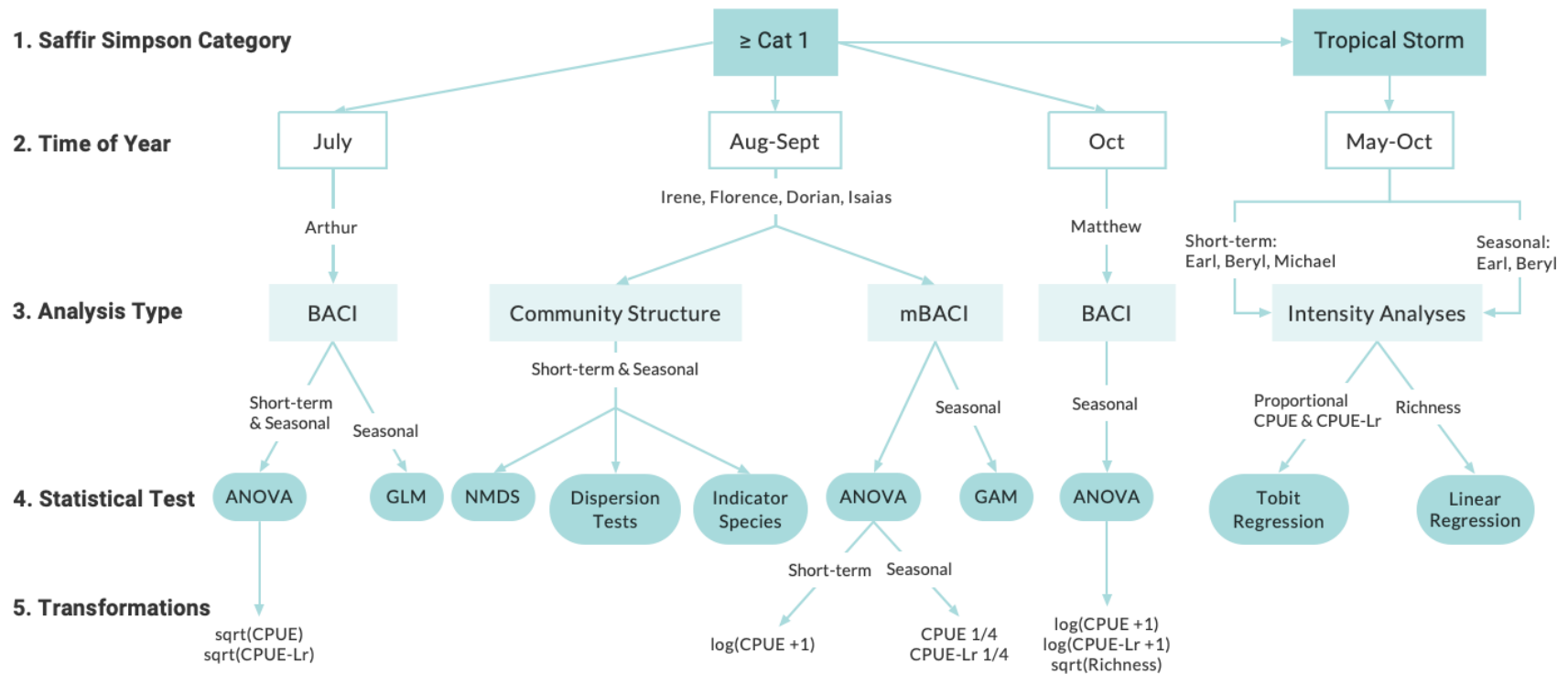
### **S1 Appendix. Literature Review Citations for Table 1**

Published studies that examined change in fish abundances before and after hurricanes listed in the literature review.

1. Adams A. Effects of a hurricane on two assemblages of coral reef fishes: Multiple-year analysis reverses a false “snapshot” interpretation. *Bull Mar Sci.* 2001;69: 341–356.
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7. Cheal A, Coleman G, Delean S, Miller I, Osborne K, Sweatman H. Responses of coral and fish assemblages to a severe but short-lived tropical cyclone on the Great Barrier Reef, Australia. *Coral Reefs.* 2002;21: 131–142.
8. Davis J, Laird B. The effects of tropical storm Agnes on the Chesapeake Bay estuarine system. The Chesapeake Reserach Consortium; 1976. Report No.: CRC Publication No. 54.
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19. Stevens PW, Blewett DA, Casey JP. Short-term effects of a low dissolved oxygen event on estuarine fish assemblages following the passage of Hurricane Charley. *Estuaries Coast*. 2006;29: 997–1003.
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# Fish Response to Hurricane Analysis Flow Chart



**S1 Figure. Statistical Analysis Flowchart and Transformations**

Decision-tree indicating how fish data was subsetted, transformed, and analyzed. If not listed as transformed, raw data was used as the response variable.

**S1 Table. Seagrass meadow locations and survey dates**

| <b>Meadow</b> | <b>Latitude</b> | <b>Longitude</b> | <b>Dominant<br/>Seagrass spp.</b> | <b>Surveys</b>  |
|---------------|-----------------|------------------|-----------------------------------|---|
| SG 1          | 34.691747       | -76.622573       | <i>Zostera marina</i>             | May-Oct 2016 (monthly)<br>Apr-Sep 2019 (monthly)                                      |
| SG 2          | 34.697874       | -76.595503       | <i>Halodule wrightii</i>          | Aug & Oct 2013<br>May & July 2014<br>May-Oct 2016 (monthly)<br>Apr-Sep 2019 (monthly) |
| SG 3          | 34.699899       | -76.592917       | <i>Halodule wrightii</i>          | Aug & Oct 2013<br>May & July 2014<br>May-Oct 2016 (monthly)<br>Apr-Sep 2019 (monthly) |
| SG 4          | 34.703403       | -76.587869       | <i>Halodule wrightii</i>          | May-Oct 2016 (monthly)<br>Apr-Sep 2019 (monthly)                                      |

Meadows surveyed for both fishes and percent cover of seagrass. Seagrass survey dates (month/year) and periodicity listed.

**S2 Table. Temperature and Salinity ANOVA summary statistics**

|                    | <b>Time Frame</b> | <b>Factor</b>    | <b>Df</b> | <b>Sum Sq</b> | <b>Mean Sq</b> | <b>F value</b> | <b>P</b> |
|--------------------|-------------------|------------------|-----------|---------------|----------------|----------------|----------|
| <b>Temperature</b> | <b>Short-term</b> | Period           | 1         | 26.3          | 26.28          | 1.741          | 0.189    |
|                    |                   | Year Type        | 1         | 18            | 19.98          | 1.191          | 0.277    |
|                    |                   | Period*Year Type | 1         | 24.9          | 24.94          | 1.652          | 0.201    |
|                    |                   | Residuals        | 150       | 2264.6        | 15.1           |                |          |
|                    | <b>Seasonal</b>   | Period           | 1         | 54            | 53.83          | 3.775          | 0.052    |
|                    |                   | Year Type        | 1         | 45            | 45.31          | 3.178          | 0.075    |
|                    |                   | Period*Year Type | 1         | 25            | 24.51          | 1.719          | 0.190    |
|                    |                   | Residuals        | 603       | 8597          | 14.26          |                |          |
| <b>Salinity</b>    | <b>Short-term</b> | Period           | 1         | 2.3           | 2.267          | 0.493          | 0.484    |
|                    |                   | Year Type        | 1         | 6.2           | 6.16           | 1.341          | 0.249    |
|                    |                   | Period*Year Type | 1         | 0.3           | 0.321          | 0.1            | 0.792    |
|                    |                   | Residuals        | 142       | 652.4         | 4.594          |                |          |
|                    | <b>Seasonal</b>   | Period           | 1         | 0             | 0.196          | 0.031          | 0.859    |
|                    |                   | Year Type        | 1         | 7             | 7.191          | 1.154          | 0.283    |
|                    |                   | Period*Year Type | 1         | 22            | 22.286         | 3.575          | 0.060    |
|                    |                   | Residuals        | 549       | 3422          | 6.234          |                |          |

ANOVAs were conducted to determine if environmental conditions differed across BACI treatments to determine whether to include as potential explanatory variables in ANOVAs and GAMs.



**S3 Table. Short-term ANOVA Summary Statistics**

| Analysis               | Response                             | ANOVA            |        |        |       |
|------------------------|--------------------------------------|------------------|--------|--------|-------|
|                        |                                      | Effect           | DF     | F      | p     |
| <b>mBACI</b>           | log(CPUE +1)<br>(km <sup>-1</sup> )  | Period           | 1, 161 | 4.935  | 0.028 |
|                        |                                      | Year Type        | 1, 161 | 0.214  | 0.644 |
|                        |                                      | Period*Year Type | 1, 161 | 2.418  | 0.122 |
|                        | CPUE-Lr<br>(km <sup>-1</sup> )       | Period           | 1, 161 | 5.328  | 0.022 |
|                        |                                      | Year Type        | 1, 161 | 0.945  | 0.333 |
|                        |                                      | Period*Year Type | 1, 161 | 2.591  | 0.109 |
|                        | Richness                             | Period           | 1, 161 | 1.627  | 0.204 |
|                        |                                      | Year Type        | 1, 161 | 10.633 | 0.001 |
|                        |                                      | Period*Year Type | 1, 161 | 2.970  | 0.087 |
| <b>Arthur<br/>BACI</b> | sqrt(CPUE)<br>(km <sup>-1</sup> )    | Period           | 1, 58  | 0.182  | 0.671 |
|                        |                                      | Year Type        | 1, 58  | 0.064  | 0.801 |
|                        |                                      | Period*Year Type | 1, 58  | 0.21   | 0.210 |
|                        | sqrt(CPUE-Lr)<br>(km <sup>-1</sup> ) | Period           | 1, 58  | 0.28   | 0.599 |
|                        |                                      | Year Type        | 1, 58  | 8.57   | 0.005 |
|                        |                                      | Period*Year Type | 1, 58  | 1.235  | 0.271 |
|                        | Richness                             | Period           | 1, 58  | 0.626  | 0.432 |
|                        |                                      | Year Type        | 1, 58  | 1.867  | 0.177 |
|                        |                                      | Period*Year Type | 1, 58  | 0.067  | 0.797 |

Summary results of short-term ANOVA tests across time period (before vs. after) and year type (control vs. impact year) for mBACI and Arthur BACI. Short-term analyses include only trawls conducted within 23 days of stormfall. Response variables were transformed when necessary to meet assumptions of parametric statistics. Post-hoc test results are not presented as no interaction term was significant.

**S4 Table. Mean values of CPUE, CPUE-Lr and Species Richness Across Treatments**

|                     | Time Frame        | Year Type | Period | n   | CPUE      |          | CPUE-Lr   |         | Species Richness |         |
|---------------------|-------------------|-----------|--------|-----|-----------|----------|-----------|---------|------------------|---------|
|                     |                   |           |        |     | Mean ± SE | %Change* | Mean ± SE | %Change | Mean ± SE        | %Change |
| <b>mBACI</b>        | <b>Short-term</b> | Control   | Before | 46  | 309 ± 65  |          | 37 ± 9    |         | 6.6 ± 0.4        |         |
|                     |                   | Control   | After  | 33  | 182 ± 22  | -41.16   | 33 ± 5    | -10.78  | 6.9 ± 0.5        | 3.95    |
|                     |                   | Impact    | Before | 53  | 261 ± 23  |          | 50 ± 4    |         | 8.5 ± 0.3        |         |
|                     |                   | Impact    | After  | 33  | 151 ± 31  | -40.17   | 29 ± 3    | -43.03  | 7.5 ± 0.4        | -11.57  |
|                     | <b>Seasonal</b>   | Control   | Before | 239 | 376 ± 26  |          | 46 ± 4    |         | 6.1 ± 0.2        |         |
|                     |                   | Control   | After  | 93  | 169 ± 18  | -55.02   | 23 ± 2    | -50     | 6.4 ± 0.3        | 4.72    |
|                     |                   | Impact    | Before | 251 | 269 ± 13  |          | 50 ± 3    |         | 6.7 ± 0.2        |         |
|                     |                   | Impact    | After  | 107 | 118 ± 15  | -56.     | 18 ± 2    | -64.14  | 6.0 ± 0.3        | -9.323  |
| <b>Arthur BACI</b>  | <b>Short-term</b> | Control   | Before | 12  | 578 ± 90  |          | 58 ± 9    |         | 4.3 ± 0.5        |         |
|                     |                   | Control   | After  | 12  | 402 ± 114 | -30.42   | 33 ± 7    | -42.27  | 4.8 ± 0.5        | 13.73   |
|                     |                   | Impact    | Before | 12  | 498 ± 127 |          | 87 ± 15   |         | 7.9 ± 0.9        |         |
|                     |                   | Impact    | After  | 26  | 582 ± 113 | 16.69    | 86 ± 14   | -1.14   | 7.5 ± 0.4        | -4.78   |
|                     | <b>Seasonal</b>   | Control   | Before | 23  | 507 ± 61  |          | 61 ± 12   |         | 4.0 ± 0.3        |         |
|                     |                   | Control   | After  | 43  | 252 ± 46  | -50.35   | 26 ± 4    | -57.98  | 5.2 ± 0.4        | 30.65   |
|                     |                   | Impact    | Before | 51  | 717 ± 67  |          | 140 ± 12  |         | 7.4 ± 0.3        |         |
|                     |                   | Impact    | After  | 70  | 335 ± 50  | -53.37   | 56 ± 7    | -60.31  | 7.9 ± 0.4        | 7.15    |
| <b>Matthew BACI</b> | <b>Seasonal</b>   | Control   | Before | 48  | 94 ± 17   |          | 16 ± 3    |         | 4.9 ± 0.3        |         |
|                     |                   | Control   | After  | 11  | 33 ± 9    | -64.74   | 5 ± 1     | -71.83  | 3.8 ± 0.4        | -21.68  |
|                     |                   | Impact    | Before | 69  | 277 ± 29  |          | 39 ± 4    |         | 7.1 ± 0.4        |         |
|                     |                   | Impact    | After  | 15  | 28 ± 5    | -89.97   | 10 ± 3    | -74.14  | 4.4 ± 0.4        | -38.42  |

Mean +/- standard error CPUE, CPUE-Lr, and species richness for multi-storm mBACI and BACI comparisons. Percent change is calculated as the decline or increase in catch or richness between before and after periods:  $\frac{\text{before} - \text{after}}{\text{before}} \times 100$ . **Note:** Means presented are rounded to whole values for catch and one decimal place for species richness. Percent change was calculated using unrounded values and may differ from calculations based upon means in the table.

**S5 Table. NMDS environmental correlates**

| <b>Factor</b>    | <b>Short-term</b> |              |          | <b>Seasonal</b> |              |          |
|------------------|-------------------|--------------|----------|-----------------|--------------|----------|
|                  | <b>NMDS1</b>      | <b>NMDS2</b> | <b>p</b> | <b>NMDS1</b>    | <b>NMDS2</b> | <b>p</b> |
| Depth            | -0.063            | 0.126        | 0.557    | 0.057           | -0.076       | 0.356    |
| Temperature      | 0.012             | -0.394       | 0.007    | -0.021          | 0.143        | 0.084    |
| Salinity         | 0.043             | -0.019       | 0.928    | -0.066          | -0.070       | 0.385    |
| Days since Storm | 0.147             | 0.134        | 0.284    | -0.240          | 0.554        | 0.001    |
| Storm Rainfall   | -0.041            | 0.209        | 0.236    | 0.030           | -0.143       | 0.088    |
| Rainfall Anomaly | 0.104             | -0.136       | 0.417    | -0.043          | -0.028       | 0.746    |
| ACE              | 0.005             | 0.166        | 0.419    | 0.011           | -0.147       | 0.085    |
| Winds            | 0.121             | -0.042       | 0.608    | -0.022          | -0.081       | 0.456    |
| Gusts            | 0.096             | 0.067        | 0.66     | -0.011          | -0.108       | 0.288    |
| Storm Surge      | -0.018            | 0.191        | 0.315    | 0.020           | -0.151       | 0.064    |
| Antecedent Rain  | 0.179             | 0.069        | 0.329    | -0.227          | 0.351        | 0.001    |

Summary results of environmental variables tested for potential correlation with fish community structure at the short-term and seasonal time frames.

**S6 Table. Contributing species to short-term and seasonal community group dissimilarities**

|   | Scientific Name   | Common Name        | Avg. contrib to dissimilarity | Cum. contrib to dissimilarity |
|---|---|--------------------|-------------------------------|-------------------------------|
| <b>Short-term</b>                                   | <b>Before Control - After Control, Overall between-group dissimilarity = 0.4430</b>     |                    |                               |                               |
|   | <i>Lagadon rhomboides</i> (Linnaeus, 1766)  | Pinfish            | 0.0436                        | 0.0931                        |
|   | <i>Gerreidae</i> spp. (Goode and Bean, 1879)  | Mojarra spp.       | 0.0435                        | 0.1859                        |
|   | <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot               | 0.0416                        | 0.2747                        |
|   | <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish            | 0.0409                        | 0.3619                        |
|   | <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                     | Flounder spp.      | 0.0380                        | 0.4429                        |
|   | <i>Bairdiella chrysoura</i> (Lacepède, 1802)  | Silver Perch       | 0.0344                        | 0.5164                        |
|   | <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish | 0.0297                        | 0.5798                        |
|   | <i>Lutjanus griseus</i> (Linnaeus, 1758)  | Grey Snapper       | 0.0287                        | 0.6409                        |
|   | <i>Lutjanus synagris</i> (Linnaeus, 1758)   | Lane Snapper       | 0.0195                        | 0.6825                        |
|   | <i>Anchoa</i> spp. (Valenciennes, 1848)   | Anchovy spp.       | 0.0172                        | 0.7192                        |
|   | <b>Before Hurricane - After Hurricane, Overall between-group dissimilarity = 0.4498</b> |                    |                               |                               |
|   | <i>Lagadon rhomboides</i> (Linnaeus, 1766)  | Pinfish            | 0.0417                        | 0.0928                        |
|   | <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish            | 0.0378                        | 0.1769                        |
|   | <i>Gerreidae</i> spp. (Goode and Bean, 1879)  | Mojarra spp.       | 0.0342                        | 0.2529                        |
|   | <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish | 0.0339                        | 0.3283                        |
|   | <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                     | Flounder spp.      | 0.0332                        | 0.4022                        |
|   | <i>Bairdiella chrysoura</i> (Lacepède, 1802)  | Silver Perch       | 0.0330                        | 0.4755                        |
|   | <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot               | 0.0324                        | 0.5474                        |
|   | <i>Archosargus probatocephalus</i> (Walbaum, 1792)                                      | Sheepshead         | 0.0308                        | 0.6160                        |
|   | <i>Lutjanus griseus</i> (Linnaeus, 1758)  | Grey Snapper       | 0.0250                        | 0.6717                        |
|   | <i>Sygnathus</i> spp. (Jordan and Gilbert 1882)   | Pipefish spp.      | 0.0184                        | 0.7126                        |
|   | <b>Before Control - Before Hurricane, Overall between-group dissimilarity = 0.4437</b>  |                    |                               |                               |
|   | <i>Lagadon rhomboides</i> (Linnaeus, 1766)  | Pinfish            | 0.0499                        | 0.1125                        |
|   | <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish            | 0.0381                        | 0.1983                        |
|   | <i>Gerreidae</i> spp. (Goode and Bean, 1879)  | Mojarra spp.       | 0.0340                        | 0.2749                        |
|   | <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot               | 0.0337                        | 0.3509                        |
|   | <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish | 0.0337                        | 0.4268                        |
|   | <i>Bairdiella chrysoura</i> (Lacepède, 1802)  | Silver Perch       | 0.0314                        | 0.4974                        |
|   | <i>Archosargus probatocephalus</i> (Walbaum, 1792)                                      | Sheepshead         | 0.0313                        | 0.5680                        |
| <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882) | Flounder spp.   | 0.0233             | 0.6205                        |                               |
| <i>Diplodus holbrookii</i> (Bean, 1878)             | Spottail pinfish  | 0.0203             | 0.6663                        |                               |
| <i>Sygnathus</i> spp. (Jordan and Gilbert 1882)     | Pipefish spp.   | 0.0178             | 0.7064                        |                               |

|   |  |                    |        |        |
|---|--|--------------------|--------|--------|
| <b>Seasonal</b>   | <b>After Control - After Hurricane, Overall between-group dissimilarity = 0.4686</b> |                    |        |        |
|   | <i>Lagadon rhomboides</i> (Linnaeus, 1766)   | Pinfish            | 0.0525 | 0.1187 |
|   | <i>Gerreidae</i> spp. (Goode and Bean, 1879)   | Mojarra spp.       | 0.0447 | 0.2199 |
|   | <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)                                     | Pigfish            | 0.0393 | 0.3089 |
|   | <i>Stephanolepis hispidus</i> (Linnaeus, 1766)                                       | Planehead filefish | 0.0340 | 0.3858 |
|   | <i>Leiostomus xanthurus</i> (Lacepède, 1802)   | Spot               | 0.0333 | 0.4610 |
|   | <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                  | Flounder spp.      | 0.0271 | 0.5224 |
|   | <i>Bairdiella chrysoura</i> (Lacepède, 1802)   | Silver Perch       | 0.0243 | 0.5774 |
|   | <i>Lutjanus griseus</i> (Linnaeus, 1758)   | Grey Snapper       | 0.0230 | 0.6294 |
|   | <i>Diplodus holbrookii</i> (Bean, 1878)  | Spottail pinfish   | 0.0196 | 0.6738 |
|   | <i>Mycteroperca microlepis</i> (Goode & Bean, 1879)                                  | Gag grouper        | 0.0140 | 0.7054 |
|   | <b>Before Control - After Control, Overall between-group dissimilarity = 0.4826</b>  |                    |        |        |
|   | <i>Lagadon rhomboides</i> (Linnaeus, 1766)   | Pinfish            | 0.0674 | 0.1396 |
| <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish  | 0.0539             | 0.2513 |        |
| <i>Gerreidae</i> spp. (Goode and Bean, 1879)  | Mojarra spp.   | 0.0508             | 0.3567 |        |
| <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot   | 0.0448             | 0.4496 |        |
| <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                     | Flounder spp.  | 0.0347             | 0.5215 |        |
| <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish   | 0.0332             | 0.5903 |        |
| <i>Bairdiella chrysoura</i> (Lacepède, 1802)  | Silver Perch   | 0.0240             | 0.6400 |        |
| <i>Lutjanus griseus</i> (Linnaeus, 1758)  | Grey Snapper   | 0.0220             | 0.6856 |        |
| <i>Opsanus tau</i> (Linnaeus 1766)  | Toadfish   | 0.0176             | 0.7222 |        |
| <i>Diplodus holbrookii</i> (Bean, 1878)   | Spottail pinfish   | 0.0158             | 0.7549 |        |
| <b>Before Hurricane - After Hurricane, Overall between-group dissimilarity = 0.5023</b> |  |                    |        |        |
| <i>Lagadon rhomboides</i> (Linnaeus, 1766)  | Pinfish  | 0.0636             | 0.1266 |        |
| <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish  | 0.0610             | 0.2480 |        |
| <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot   | 0.0473             | 0.3422 |        |
| <i>Gerreidae</i> spp. (Goode and Bean, 1879)  | Mojarra spp.   | 0.0389             | 0.4197 |        |
| <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                     | Flounder spp.  | 0.0376             | 0.4945 |        |
| <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish   | 0.0372             | 0.5685 |        |
| <i>Bairdiella chrysoura</i> (Lacepède, 1802)  | Silver Perch   | 0.0306             | 0.6294 |        |
| <i>Archosargus probatocephalus</i> (Walbaum, 1792)                                      | Sheepshead   | 0.0219             | 0.6731 |        |
| <i>Diplodus holbrookii</i> (Bean, 1878)   | Spottail pinfish   | 0.0184             | 0.7098 |        |
| <i>Lutjanus griseus</i> (Linnaeus, 1758)  | Grey Snapper   | 0.0178             | 0.7452 |        |
| <b>Before Control - Before Hurricane, Overall between-group dissimilarity = 0.4432</b>  |  |                    |        |        |
| <i>Lagadon rhomboides</i> (Linnaeus, 1766)  | Pinfish  | 0.0580             | 0.1309 |        |
| <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)  | Pigfish  | 0.0544             | 0.2537 |        |
| <i>Leiostomus xanthurus</i> (Lacepède, 1802)  | Spot   | 0.0456             | 0.3566 |        |
| <i>Stephanolepis hispidus</i> (Linnaeus, 1766)  | Planehead filefish   | 0.0358             | 0.4373 |        |
| <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                     | Flounder spp.  | 0.0329             | 0.5114 |        |

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|  |                    |        |        |
|--|--------------------|--------|--------|
| <i>Gerreidae</i> spp. (Goode and Bean, 1879)   | Mojarra spp.       | 0.0242 | 0.5659 |
| <i>Bairdiella chrysoura</i> (Lacepède, 1802)   | Silver Perch       | 0.0239 | 0.6198 |
| <i>Diplodus holbrookii</i> (Bean, 1878)  | Spottail pinfish   | 0.0206 | 0.6663 |
| <i>Sygnathus</i> spp. (Jordan and Gilbert 1882)                                      | Pipefish spp.      | 0.0183 | 0.7077 |
| <i>Opsanus tau</i> (Linnaeus 1766)   | Toadfish           | 0.0180 | 0.7482 |
| <b>After Control - After Hurricane, Overall between-group dissimilarity = 0.4856</b> |                    |        |        |
| <i>Lagadon rhomboides</i> (Linnaeus, 1766)   | Pinfish            | 0.0596 | 0.1228 |
| <i>Orthopristis chrysoptera</i> (Linnaeus, 1766)                                     | Pigfish            | 0.0543 | 0.2346 |
| <i>Gerreidae</i> spp. (Goode and Bean, 1879)   | Mojarra spp.       | 0.0471 | 0.3316 |
| <i>Leiostomus xanthurus</i> (Lacepède, 1802)   | Spot               | 0.0426 | 0.4194 |
| <i>Paralichthys</i> spp. (Jordan and Gilbert, 1882)                                  | Flounder spp.      | 0.0412 | 0.5044 |
| <i>Bairdiella chrysoura</i> (Lacepède, 1802)   | Silver Perch       | 0.0314 | 0.5691 |
| <i>Lutjanus griseus</i> (Linnaeus, 1758)   | Grey Snapper       | 0.0296 | 0.6301 |
| <i>Stephanolepis hispidus</i> (Linnaeus, 1766)                                       | Planehead filefish | 0.0285 | 0.6888 |
| <i>Lutjanus synagris</i> (Linnaeus, 1758)  | Lane Snapper       | 0.0188 | 0.7274 |
| <i>Archosargus probatocephalus</i> (Walbaum, 1792)                                   | Sheepshead         | 0.0158 | 0.7599 |

Results of Similarity Percentages (SIMPER) analysis indicating the species that contribute the most to dissimilarity across mBACI groups based on Bray-Curtis dissimilarities calculated from fourth-root transformed abundance data. Only the top 10 species that contribute the most to between-group dissimilarities are listed.

**S7 Table. Seasonal ANOVA and Tukey HSD for mBACI, Arthur- and Matthew BACIs**

|                  | Response                                      | ANOVA            |        |        |               | Tukey HSD     |                |
|------------------|---|------------------|--------|--------|---------------|---------------|----------------|
|                  |   | Effect           | DF     | F      | p             | Comparison    | p              |
| mBACI            | CPUE <sup>1/4</sup><br>(km <sup>-1</sup> )    | Period           | 1, 650 | 77.463 | <0.001        |               |                |
|                  |   | Year Type        | 1, 650 | 2.983  | 0.085         |               |                |
|                  |   | Period*Year Type | 1, 650 | 2.069  | 0.151         |               |                |
|                  | CPUE-Lr <sup>1/4</sup><br>(km <sup>-1</sup> ) | Period           | 1, 650 | 59.551 | <0.001        | CB-IB         | 0.517          |
|                  |   | Year Type        | 1, 650 | 0.001  | 0.976         | CA-IA         | 0.120          |
|                  |   | Period*Year Type | 1, 650 | 6.802  | 0.009*        | CB-CA & IB-IA | 0.002, <0.001  |
|                  |   |                  |        |        |               | CB-IA, IB-CA  | <0.001, <0.001 |
|                  | Richness                                      | Period           | 1, 650 | 0.484  | 0.487         | CB-IB         | 0.155          |
|                  |   | Year Type        | 1, 650 | 1.467  | 0.226         | CA-IA         | 0.725          |
| Period*Year Type |   | 1, 650           | 4.016  | 0.046* | CB-CA & IB-IA | 0.798, 0.219  |                |
|                  |   |                  |        |        | CB-IA, IB-CA  | 0.987, 0.907  |                |
| Arthur BACI      | sqrt(CPUE)<br>(km <sup>-1</sup> )             | Period           | 1, 183 | 47.707 | <0.001        |               |                |
|                  |   | Year Type        | 1, 183 | 4.473  | 0.0358        |               |                |
|                  |   | Period*Year Type | 1, 183 | 0.255  | 0.614         |               |                |
|                  | sqrt(CPUE-Lr)<br>(km <sup>-1</sup> )          | Period           | 1, 183 | 70.995 | <0.001        |               |                |
|                  |   | Year Type        | 1, 183 | 32.801 | <0.001        |               |                |
|                  |   | Period*Year Type | 1, 183 | 3.379  | 0.068         |               |                |
|                  | Richness                                      | Period           | 1, 183 | 0.198  | 0.657         |               |                |
|                  |   | Year Type        | 1, 183 | 7.078  | 0.009         |               |                |
|                  |   | Period*Year Type | 1, 183 | 0.418  | 0.519         |               |                |
| Matthew BACI     | log(CPUE +1)<br>(km <sup>-1</sup> )           | Period           | 1, 139 | 50.137 | <0.001        | CB-IB         | <0.001         |
|                  |   | Year Type        | 1, 139 | 30.256 | <0.001        | CA-IA         | <0.001         |
|                  |   | Period*Year Type | 1, 139 | 6.689  | 0.011*        | CB-CA & IB-IA | 0.102, <0.001  |
|                  |   |                  |        |        |               | CB-IA, IB-CA  | 0.880, <0.001  |
|                  | log(CPUE-Lr +1)<br>(km <sup>-1</sup> )        | Period           | 1, 139 | 22.756 | <0.001        |               |                |
|                  |   | Year Type        | 1, 139 | 25.473 | <0.001        |               |                |
|                  |   | Period*Year Type | 1, 139 | 0.828  | 0.364         |               |                |
|                  | sqrt(Richness)<br>(km <sup>-1</sup> )         | Period           | 1, 139 | 14.66  | <0.001        |               |                |
|                  |   | Year Type        | 1, 139 | 21.04  | <0.001        |               |                |
| Period*Year Type |   | 1, 139           | 2.25   | 0.136  |               |               |                |

Summary results of seasonal-scale ANOVA tests across time period (before vs. after) and year type (control vs. impact year). Seasonal analyses include trawls conducted during the months of May-October. Response variables were transformed when necessary to meet assumptions of parametric statistics. Post-hoc test results are presented when the interaction term is significant at  $p < 0.05$ . Abbreviations indicate treatments; CB = control before, IB = impact before, CA = control after, IA = impact after

**S8 Table. GAM Model Summary Statistics for Seasonal mBACI**

|               |                 |                  | edf    | p      | logLik  | Dev   | df.r  | AIC    | BIC    |
|---------------|-----------------|------------------|--------|--------|---------|-------|-------|--------|--------|
| <b>Season</b> | <b>CPUE</b>     | Control : Before | 0.901  | 0.044  | -2201.3 | 280.2 | 237.1 | 4409.1 | 4420.3 |
|               |                 | Impact : Before  | 0.023  | 0.356  | -2217.0 | 273.8 | 250.0 | 4438.1 | 4445.4 |
|               |                 | Control : After  | 1.785  | <0.001 | -773.7  | 103.0 | 90.2  | 1555.4 | 1565.4 |
|               |                 | Impact : After   | 1.708  | <0.001 | -846.4  | 119.5 | 104.3 | 1700.6 | 1711.0 |
|               | <b>CPUE-Lr</b>  | Control : Before | 0.637  | 0.129  | -1703.6 | 278.3 | 237.4 | 3413.0 | 3423.3 |
|               |                 | Impact : Before  | 0.003  | 0.426  | -1817.2 | 290.9 | 250.0 | 3638.4 | 3645.5 |
|               |                 | Control : After  | 1.672  | <0.001 | -582.9  | 99.4  | 90.3  | 1173.5 | 1183.2 |
|               |                 | Impact : After   | 1.545  | <0.001 | -653.7  | 126.3 | 104.5 | 1314.8 | 1324.7 |
|               | <b>Richness</b> | Control : Before | <0.001 | 0.466  | -539.6  | 218.1 | 238.0 | 1083.2 | 1090.2 |
|               |                 | Impact : Before  | 1.755  | <0.001 | -559.8  | 199.1 | 248.2 | 1127.4 | 1141.0 |
|               |                 | Control : After  | 1.437  | 0.001  | -220.1  | 89.9  | 90.6  | 447.8  | 457.3  |
|               |                 | Impact : After   | 1.711  | <0.001 | -241.0  | 106.7 | 104.3 | 489.8  | 500.1  |

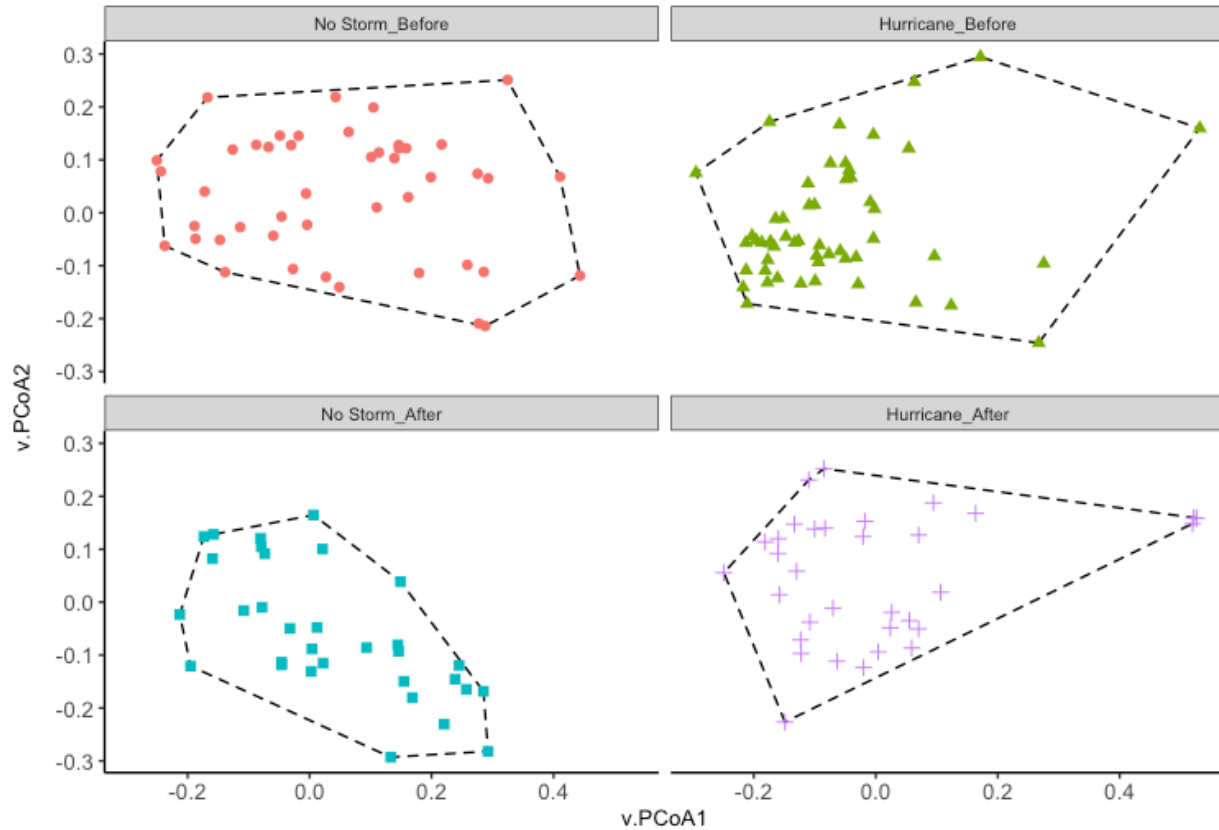
All GAM models were run for the seasonal time frame against days since storm as the independent variable and built using a cubic regression spline with penalized shrinkage, a maximum of three degrees of freedoms, negative binomial error distribution with log link function, and restricted maximum likelihood smoothing parameter. edf = effective degrees of freedom, logLik = log likelihood, Dev = deviance, df.r = residual degrees of freedom, AIC = Akaike information criterion BIC = Bayesian information criterion.



**S9 Table. Hurricane Arthur GLM Summary Statistics**

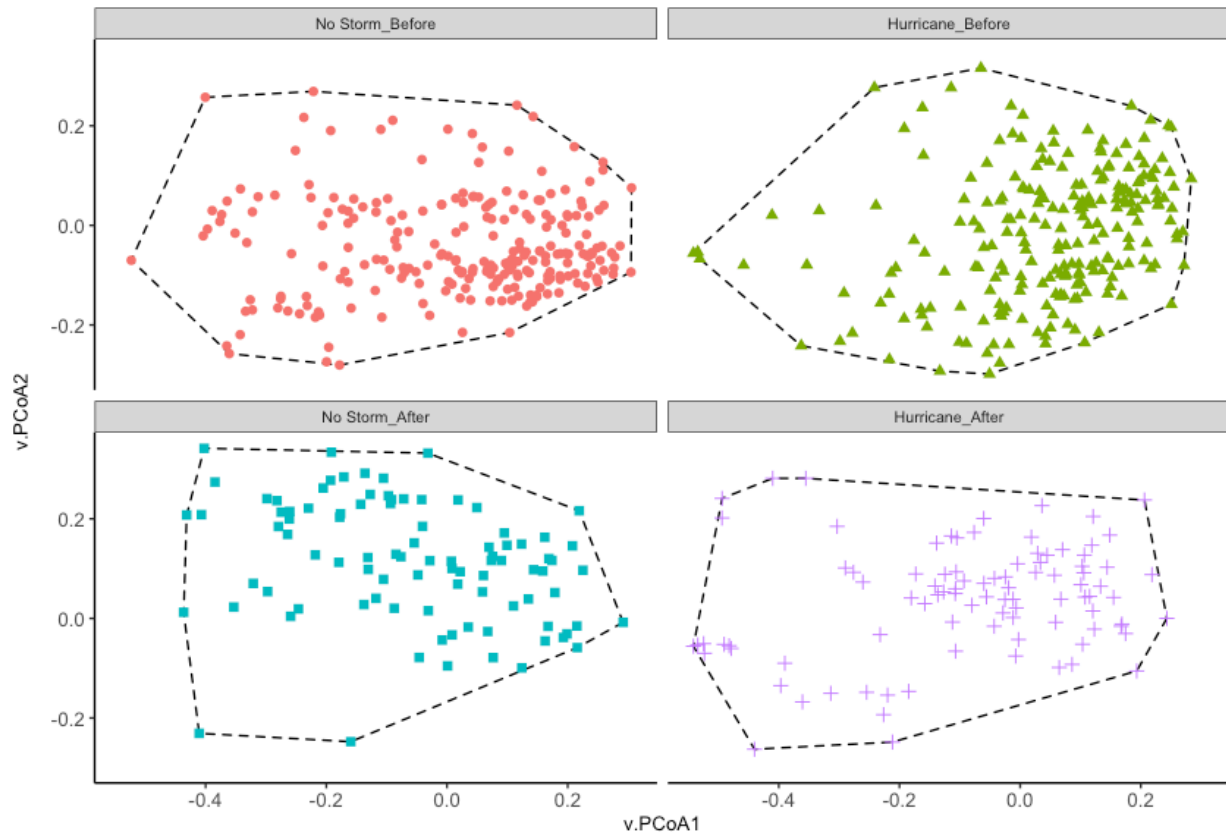
|                 |                  |                  | Term             | Est.   | z-value | P-value | df.r  | AIC   | BIC |
|-----------------|------------------|------------------|------------------|--------|---------|---------|-------|-------|-----|
| <b>Arthur</b>   | <b>CPUE</b>      | Control : Before | Intercept        | 6.504  | 21.033  | <0.001  | 21    | 330   | 333 |
|                 |                  |                  | Period*Year Type | 0.010  | 1.021   | 0.307   |       |       |     |
|                 |                  | Impact : Before  | Intercept        | 5.798  | 17.812  | <0.001  | 49    | 763   | 769 |
|                 |                  |                  | Period*Year Type | -0.022 | -2.414  | 0.016   |       |       |     |
|                 |                  | Control : After  | Intercept        | 6.081  | 18.135  | <0.001  | 41    | 561   | 566 |
|                 |                  |                  | Period*Year Type | -0.010 | -2.131  | 0.033   |       |       |     |
|                 | Impact : After   | Intercept        | 6.558            | 42.047 | <0.001  | 68      | 919.3 | 926.1 |     |
|                 |                  | Period*Year Type | -0.020           | -8.100 | <0.001  |         |       |       |     |
|                 | <b>CPUE-Lr</b>   | Control : Before | Intercept        | 3.999  | 9.768   | <0.001  | 21    | 240   | 243 |
|                 |                  |                  | Period*Year Type | -0.004 | -0.311  | 0.756   |       |       |     |
|                 |                  | Impact : Before  | Intercept        | 4.358  | 13.614  | <0.001  | 49    | 597   | 603 |
|                 |                  |                  | Period*Year Type | -0.017 | 13.872  | 0.060   |       |       |     |
|                 |                  | Control : After  | Intercept        | 3.874  | 13.872  | <0.001  | 41    | 367   | 372 |
|                 |                  |                  | Period*Year Type | -0.012 | -2.814  | 0.005   |       |       |     |
|                 | Impact : After   | Intercept        | 4.650            | 30.441 | <0.001  | 68      | 681   | 687   |     |
|                 |                  | Period*Year Type | -0.016           | -6.520 | <0.001  |         |       |       |     |
|                 | <b>Richness</b>  | Control : Before | Intercept        | 2.149  | 11.904  | <0.001  | 21    | 104   | 107 |
|                 |                  |                  | Period*Year Type | 0.009  | 1.564   | 0.118   |       |       |     |
| Impact : Before |                  | Intercept        | 2.126            | 12.479 | <0.001  | 49      | 236   | 242   |     |
|                 |                  | Period*Year Type | 0.004            | 0.735  | 0.463   |         |       |       |     |
| Control : After |                  | Intercept        | 1.959            | 14.332 | <0.001  | 41      | 217   | 222   |     |
|                 |                  | Period*Year Type | -0.002           | -0.750 | 0.454   |         |       |       |     |
| Impact : After  | Intercept        | 2.067            | 25.078           | <0.001 | 68      | 371     | 377   |       |     |
|                 | Period*Year Type | <0.001           | 0.029            | 0.977  |         |         |       |       |     |

Negative binomial generalized linear models for seasonal-scale trend analysis of Hurricane Arthur (2014) versus 2015 as the control year. Est = estimate, df.r = residual degrees of freedom, AIC = Akaike information criterion BIC = Bayesian information criterion.



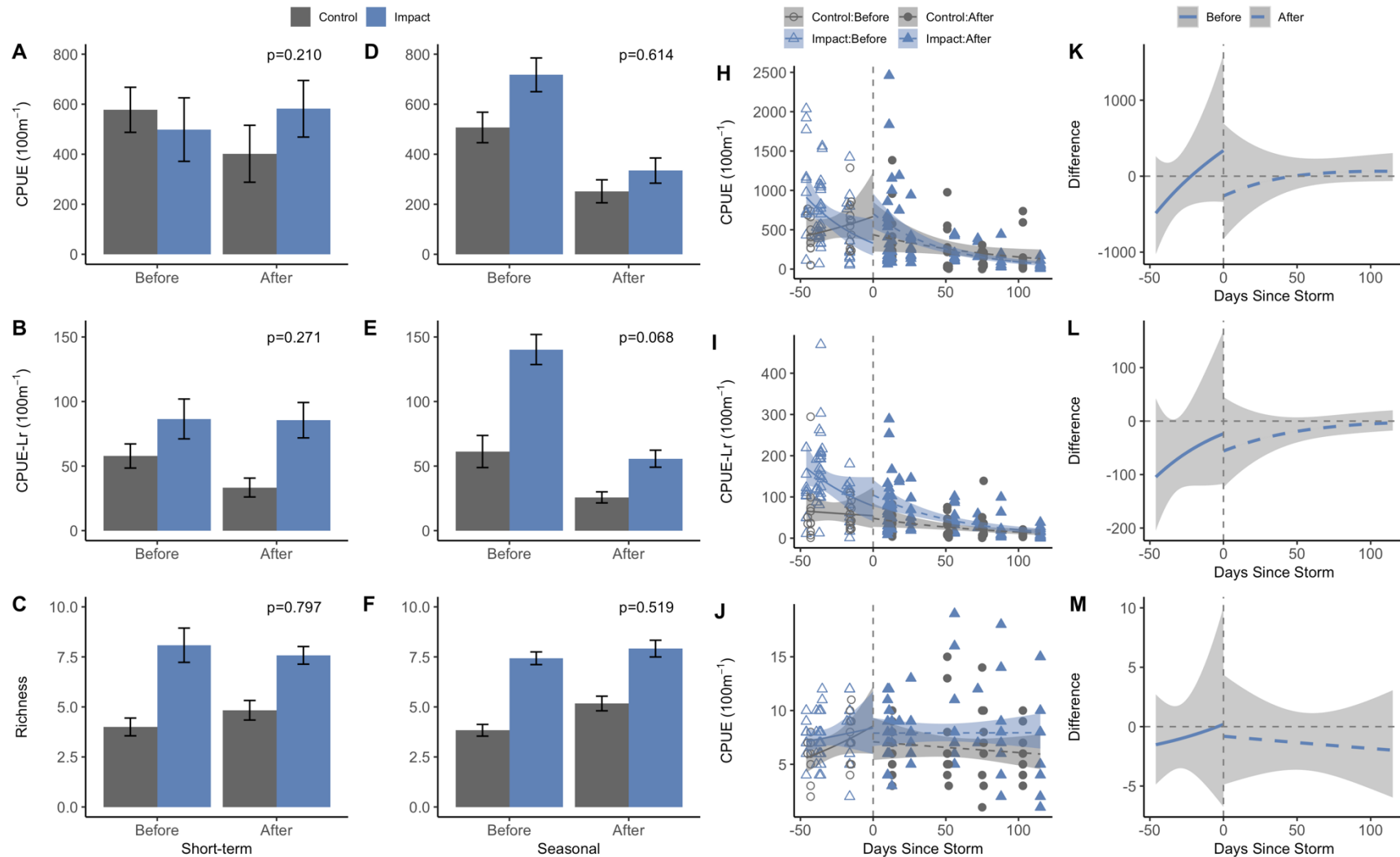
**S2 Figure. Individual mBACI treatment PCoA ordinations of short-term communities**

This figure demonstrates the potential difference/lack of difference in short-term community dispersion within each mBACI treatment using Principle Coordinates Analysis. Convex hulls are drawn in dashed lines through the outer-most points.

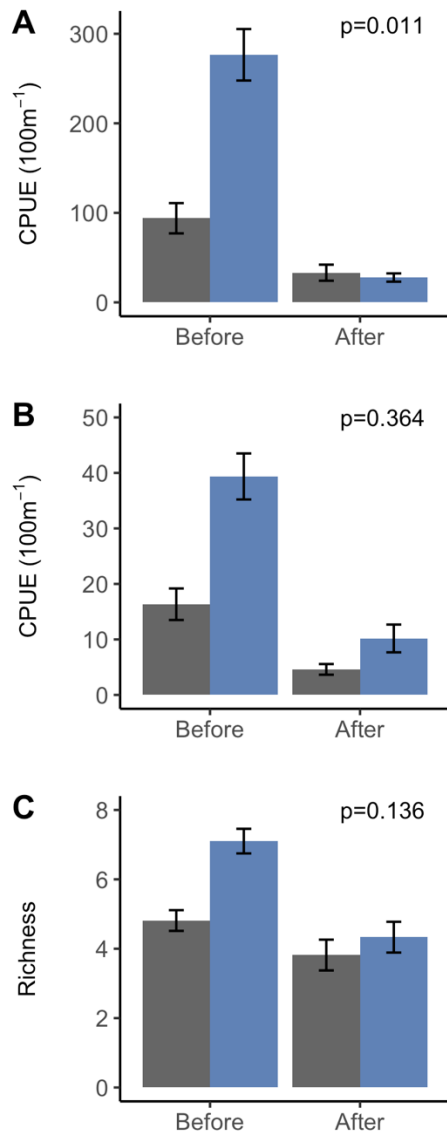


**S3 Figure. Individual mBACI group PCoA ordinations of seasonal communities**

This figure demonstrates the potential difference/lack of difference in seasonal community dispersion within each mBACI treatment using Principle Coordinates Analysis. Convex hulls are drawn in dashed lines through the outer-most points.



**S4 Figure.** Short-term and seasonal fish catches and species richness across time periods and year type for Hurricane Arthur (July 2014) compared to 2015 (control year). Only means are presented for short-term comparisons (column 1); whereas means, trend, and difference between control and impact trends (columns 2-4, respectively) are depicted for seasonal comparisons. Catch per unit effort (CPUE) is presented in row 1; CPUE calculated sans *L. rhomboides* is presented in row 2, and species richness is row 3. P-values indicate the significance of the interactive ANOVA term. Error bars represent standard error. Smoothed lines represent generalized additive models ( $y \sim s(\text{Days to Storm})$ ,  $k = 3$ ) for both hurricane and storm-free years based on a cubic regression spline with shrinkage and 95% confidence intervals.



**S5 Figure.** Seasonal fish catch per unit effort (A), catch per unit effort sans *Lagodon rhomboides* (B) and species richness (C) across time periods (before vs. after) and year type (control vs. impact) for Hurricane Matthew (October 2016) compared to 2017 (control year). Only means are presented for seasonal comparisons (column 1), as the closest trawl samples prior to hurricane Matthew occurred outside of the short-term window and all trawls that occurred after the storm were conducted on the same day. P-values indicate the significance of the interactive ANOVA term. Error bars represent standard error.