*Appendix 2 Detailed descriptions of all models fit to data for each question.*

## *Question 1: Oyster restoration response across Pensacola, St. Andrew, and Apalachicola bays*

From the GLM models, the dispersion parameter from the negative binomial distribution ("nbinom2" family formulation) was <1 for all models, suggesting over-dispersion. The best fitting model for oyster spat (lowest AICcC value, highest AICcC weight) was the Period + Bay + (Period | Site) + Period:Bay + offset(log(Num\_quads)) (Table 2). Because site is uniquely coded, this model allows different responses by site over time in each bay. No autocorrelation in residuals was detected (K-S test p= 0.40; D-W test p = 0.18). The significant interaction term suggests that each bay's temporal patterns in oyster counts are unique. Apalachicola Bay live spat counts per quadrat declined (beta of the slope = -0.004, SE = 0.07, 95% CI = -0.15 – 0.14) and this trend was not significantly different from zero (p = 0.96). Pensacola and St. Andrew bays show uncertain trends in oyster spat counts. Pensacola coefficient values for the slope of oyster spat counts over time were larger than Apalachicola (beta = -0.39, SE = 0.11, 95% CI = -0.61 – 0.17) and this slope coefficient did differ from zero (p=0.0006). For St. Andrew Bay, the slope coefficient was highly uncertain (beta = 0.21, SE = 0.18, 95% CI = -0.14 – 0.57) and this slope did not differ from zero (p=0.23).

## *Question 2 how do oyster spat temporal trends vary among separate restoration projects in Apalachicola Bay?*

To examine trends in Apalachicola Bay oyster spat by project, we fit eight different models to the data (Table 2). To simplify nesting of site within project in our model structure (which would allow period to vary by site across project), we created a new variable (SP) which combined the site and project name. Creating the variable SP allows different responses by site over time in each project. The best fitting model for oyster spat (lowest AICcC value, highest AICcC weight) was the Period + Project + (Period | SP) + Period:Project + offset(log(Num\_quads)) (Table 3). Autocorrelation in residual results were mixed as the K-S test was not significant (K-S test p= 0.21) but the Durbin-Watson test was (D-W test p = 0.03) likely due to different numbers of sites sampled with each project. No adjustment was made. The trend in live oyster spat counts per quadrat over time did not differ from zero for projects GEBF-5007 (slope coefficient beta = -0.06, SE = 0.10, 95% CI = -0.26 – 0.13, p = 0.51), NRDA-4044 (slope coefficient beta = 0.04, SE = 0.07, 95% CI = -0.09 – 0.18, p = 0.51) or NFWF-2021 (slope coefficient beta = -1.04, SE = 0.60, 95% CI = -2.24 – 0.15, p = 0.09). For project NFWF-1, the trend in live oyster spat per quadrat was significantly different from zero (p<0.0001) and this trend was negative (slope coefficient beta = -0.64, SE = 0.15, 95% CI = -0.94 – -0.35.

*Question 3 are oyster spat counts in Apalachicola Bay associated with freshwater discharge?*

We then fit four additional models (Table 4) that compared the best fit model from Question 2 (Table 3) to models with terms describing the number of days river discharge was below 12,000 CFS, days below 12,000 CFS lagged by 1 period, number of days river discharge was below 6,000 CFS and days below 6,000 CFS lagged by 1 period (Table 3). Including these river discharge metrics did not improve model fit (Table 3).

*Question 4: Is cultch biomass related to the number of live oysters?*

Four models all had similar AICc values (within three AICc units) and the model with the highest weight (0.38) was the most complicated model Roundwt ~ (1 | SP) + Spat\_sum + Period + Project + (0 + Period | SP) + Period:Project + offset(log(Num\_quads)) which also allowed for a unique negative binomial dispersion parameter. Diagnostic assessments of model fitting for these models suggests that several may be overparameterized. We examined nine simpler models to assess whether including the number of live spat did not improve model fit (Table 5). For these simpler models, model fit was not improved by including oyster spat counts as a main effect (across all projects) or as an interaction term for each project (Table 5). The lowest AICc and highest model weight was for a model that did not include information on oyster spat (Table 5). This suggests live oyster spat did not influence oyster cultch biomass.

*Question 5: How does cultch material persist?*

We plotted the weight per quadrat (kg) by bay and project over period to assess patterns (Figure 12). For Pensacola and St. Andrew, the cultch material used for project NRDA-4044 was limestone or granite (Table 1). Plotting the biomass of this material per quadrat over time (Figure 13) demonstrated a widespread in the amount of material collected over time but no strong indication of an increase or decline. Because Apalachicola Bay is the only system where multiple materials (rock and shell) have been used for different projects, we were able to examine Apalachicola Bay for more insight into cultch persistence by project (Figures 13-14). We fit the same GLM models described previously first to compare all bays (Question 1) and to compare projects within Apalachicola Bay (Question 2).

In comparing the persistence of cultch material across the three bays, the Roundwt ~ Period + Bay + (Period | Site) + Period:Bay + offset(log(Num\_quads)) model did not converge with either the default or the BFGS optimizer. From an AICcC perspective a simpler models the Roundwt ~ Period + Bay + (1 | Site) + Period:Bay + offset(log(Num\_quads)) was the top model (lowest AICc value and AICc Weight = 0.56; Table 5.

Apalachicola Bay cultch biomass per quadrat had a positive slope (beta of the slope = 0.04, SE = 0.02, 95% CI = 0.008 – 0.07) and this trend was significantly different from zero (p = 0.02). Pensacola beta values for the slope of oyster spat counts over time were negative (beta = -0.03, SE = 0.03, 95% CI = -0.08 – 0.03) and this slope did differ from zero (p=0.02). For St. Andrew Bay, the slope was highly uncertain (beta = -0.07, SE = 0.05, 95% CI = -0.20 – 0.05) and this slope did not differ from zero (p=0.23). We then predicted the marginal means of oyster biomass from a single ¼-m2 quadrat in Period 15 for comparison purposes between each bay. Predicted live oyster spat for Apalachicola was 3.76 kg cultch per quadrat (95% CI 2.54 –5.56), Pensacola was 1.71 kg cultch per quadrat (95% CI 0.99 – 2.94), and St. Andrew Bay predicted cultch per quadrat was 1.34 kg (95% CI 0.46 – 3.85).

The same general GLM models fit to the counts of live oyster spat with Apalachicola Bay (Question2) were then fit to the four projects for Apalachicola Bay. The top 3 models (delta AICC< 3) were the Roundwt ~ Period + Bay + (Period | Site) + Period:Bay + offset(log(Num\_quads)) followed by the Round\_wt ~ Period + Project + (Period | Site) + Period:Project + offset(log(Num\_quads)) and Round\_wt ~ (1 | SP) + Period + Project + (0 + Period | SP) + Period:Project + offset(log(Num\_quads)) models. AICc weights were 0.45, 0.24, and 0.23 respectively.

The significant interaction term suggests that each project's temporal patterns in oyster cultch biomass are unique. The FWC-2021 project cultch biomass per quadrat had a positive slope over time (beta of the slope = 0.09, SE = 0.11, 95% CI = -0.14 – 0.31) and this trend was not significantly different from zero (p = 0.44). The GEBF-5007 project beta values for the slope of oyster spat counts over time were positive (beta = 0.05, SE = 0.02, 95% CI = 0.01 – 0.09) and this slope did differ from zero (p=0.02). For the NFWF-1 project, the slope was negative (beta = -0.14, SE = 0.02, 95% CI = -0.19 – -0.09) and this slope did differ from zero (p<0.0001). Finally, for the NRDA-4044 project the slope was negative (beta = -0.05, SE = 0.01, 95% CI = -0.07 – -0.02) and this slope did differ from zero (p=0.0002).