

Text S1. Logical framework

g1: Abundance is a function of habitat and turbidity. Structurally complex habitats harbor higher densities of juvenile blue crabs relative to unstructured habitats. Hence, relative to sand habitat, juvenile blue crab density is higher seagrass, SME, and SDH (Orth & van Montfrans 1987, Etherington & Eggleston 2000, Heck et al. 2001, Johnson & Eggleston 2010, Hyman et al. 2022). Meanwhile, high local turbidity increases juvenile abundance through both bottom-up (Seitz et al. 2003, 2005) and potentially top-down (O'Brien et al. 1976, Ajemian et al. 2015) mechanisms (see methods in Hyman et al. 2022, for more details).

g2: Abundance is a function of habitat, turbidity, and an interaction between habitat and turbidity. Here, the effect of turbidity is dependent on a particular habitat. Whereas seagrass meadows are absent from high-turbidity areas due to light requirements, extensive salt marshes and unstructured sand habitats occur in both high- and low-turbidity regions of the tributaries. Turbidity may therefore modify the effectiveness of these habitats as nurseries for juvenile crabs by decreasing predator foraging efficiency through both low visibility (turbidity) and structural impediments (in SME or SDH; Ajemian et al. 2015, Hyman et al. 2022).

g3: Abundance is a function of habitat, turbidity and spatial position. Recruitment in a given location is dependent on postlarval supply (Beck et al. 2001, Gillanders et al. 2003, Sheaves et al. 2006). Blue crab postlarvae enter tributaries from the mouth (i.e. downriver), and decline with distance upriver along the tributary axis as they encounter suitable habitat and settle (Stockhausen & Lipcius 2003). Hence, we expected habitats positioned closer to the mouth of the river would be associated with higher juvenile abundances due to proximity to postlarval supply.

g4: Abundance is a function of habitat, turbidity, spatial position, and an interaction between habitat and spatial position. Environmental conditions vary substantially along tributary axes (e.g. Posey et al. 2005). Latent variables influencing juvenile abundance may inconsistently affect habitats. As a consequence, the effects of spatial position are habitat-specific (Sheaves et al. 2015, Nagelkerken et al. 2015).

g5: Abundance is a function of habitat, turbidity, spatial position, and an interaction between habitat and turbidity (Hyman et al. 2022).

g6: Abundance is a function of habitat, turbidity, spatial position, an interaction between habitat and spatial position, and an interaction between habitat and turbidity.

Additional environmental variables other than turbidity may augment habitat suitability at different spatial positions, such as salinity (e.g. Posey et al. 2005) or food availability (e.g. Seitz et al. 2005).

Text S2. Prior distributions for gear efficiency

As different sampling methods were employed for the four habitat types, gear efficiency estimates were required to scale abundance estimates for each sample. Efficiency of the suction sampling methodology is estimated at 0.88 (Orth & van Montfrans 1987). Meanwhile, juvenile blue crab depletion experiments for benthic scrape gear suggested efficiency between 0.21 and 0.45 (Ralph & Lipcius 2014). However, benthic scrapes used here differed slightly in that they did not include iron teeth, which may decrease efficiency. Finally, pilot efficiency tests of the modified flume net design using marked blue crabs in fall of 2020 indicated an estimated efficiency of 0.92. These efficiency tests were combined with similar tests on juvenile blue crabs (Carroll 2002). This resulted in a combined five trials using 55 marked juvenile blue crabs (Table S2). Probability of recapture (i.e. efficiency) was modeled as a beta distribution with a beta(1,1) prior and a binomial likelihood using data from all 55 animals. This resulted in a beta(50,7) posterior probability distribution centered on 0.88 and variance 0.002 (standard deviation 0.04).

We constructed normally distributed prior distributions for each gear type based on estimates from literature and observed data and subsequently applied a log-transformation to relate prior estimates of efficiency to the model scale. For flume traps, the prior distribution was $\ln N(0.88, 0.002)$ to approximate the beta(50, 7) in the pilot study. This has a mean of -0.13 and standard deviation of 0.05. Similarly, for scrape estimates, we assumed the mean efficiency was 0.33 (average of 0.45 and 0.21) and a standard deviation of 0.12 to yield a prior of $\ln N(0.33, 0.12)$ which has a mean of -1.2 and standard deviation of 0.18. Finally, for suction sampling, average efficiency is 0.88 (Orth & van Montfrans 1987), although uncertainty estimates were not supplied in literature. Here, we assumed an efficiency standard deviation of 0.04 and applied a prior of $\ln N(0.88, 0.0016)$ which has a mean of -0.13 and standard deviation of 0.04.

Table S1: Table displaying the number of samples for each habitat by trip. Five of the total 144 samples were expunged due to missing predictor values (i.e. Secchi disk depth) in seagrass (two samples) and SDH (three samples)

| Habitat | Trip 1 | Trip 2 | Trip 3 | Trip 4 | Total |
|----------------|---------------|---------------|---------------|---------------|--------------|
| SME | 0 | 6 | 6 | 6 | 18 |
| SDH | 15 | 18 | 18 | 0 | 51 |
| Seagrass | 4 | 6 | 6 | 0 | 16 |
| Sand | 18 | 18 | 18 | 0 | 54 |

Table S2: Table displaying the efficiency trials used in the pilot study as well as those from Carroll (2002). Note that Carroll (2002) did not specify the number of individuals per trial, and thus the aggregate (across both trials) is reported here

| Study | Year | Marked | Recovered | Efficiency |
|----------------|-------------|---------------|------------------|-------------------|
| Present study | 2020 | 10 | 9 | 0.9 |
| Present study | 2020 | 15 | 13 | 0.86 |
| Present study | 2020 | 12 | 12 | 1 |
| Carroll (2002) | 2002 | 18 | 15 | 0.83 |
| Total | | 55 | 49 | 0.89 |

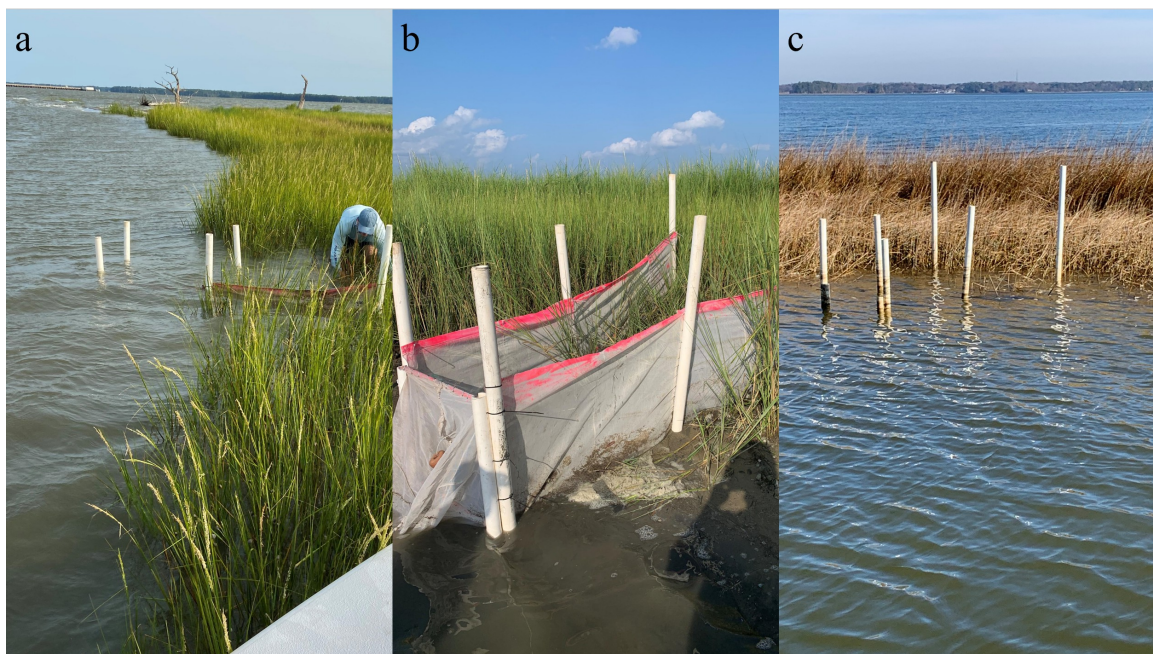


Fig. S1: Images of flume net in multiple stages of deployment: **a)** depicts a flume net set up at slack flood tide; **b)** denotes flume net collected at slack ebb tide; and **c)** denotes flume in non-deployment stage with net walls down and end removed when net is not in use. When not in use, enclosures remained on site with the net walls folded and staked into the ground and the end removed, which facilitated movement of animals throughout marsh habitat. Prior to use, walls of the flume nets were rapidly erected to contain all animals occupying the habitat at the time of sampling.

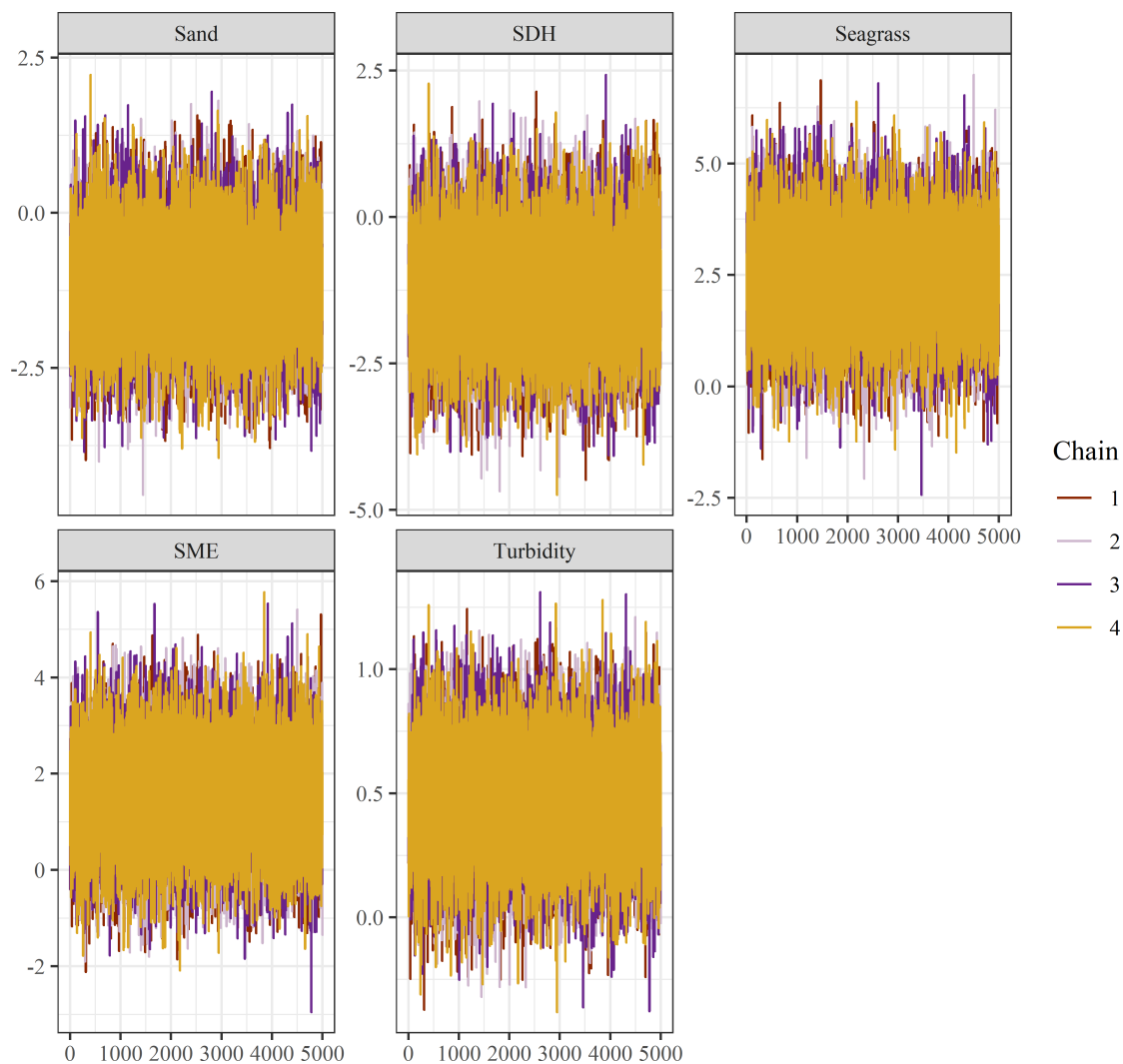


Fig. S2: A set of trace plots for model g_1 parameters illustrating posterior values of each regression coefficient per Markov chain throughout the post-warmup/adaptive phase for the ≤ 10 mm size class as an example of chain convergence. Visual inspection of trace plots is used to evaluate convergence and mixing of the chains.

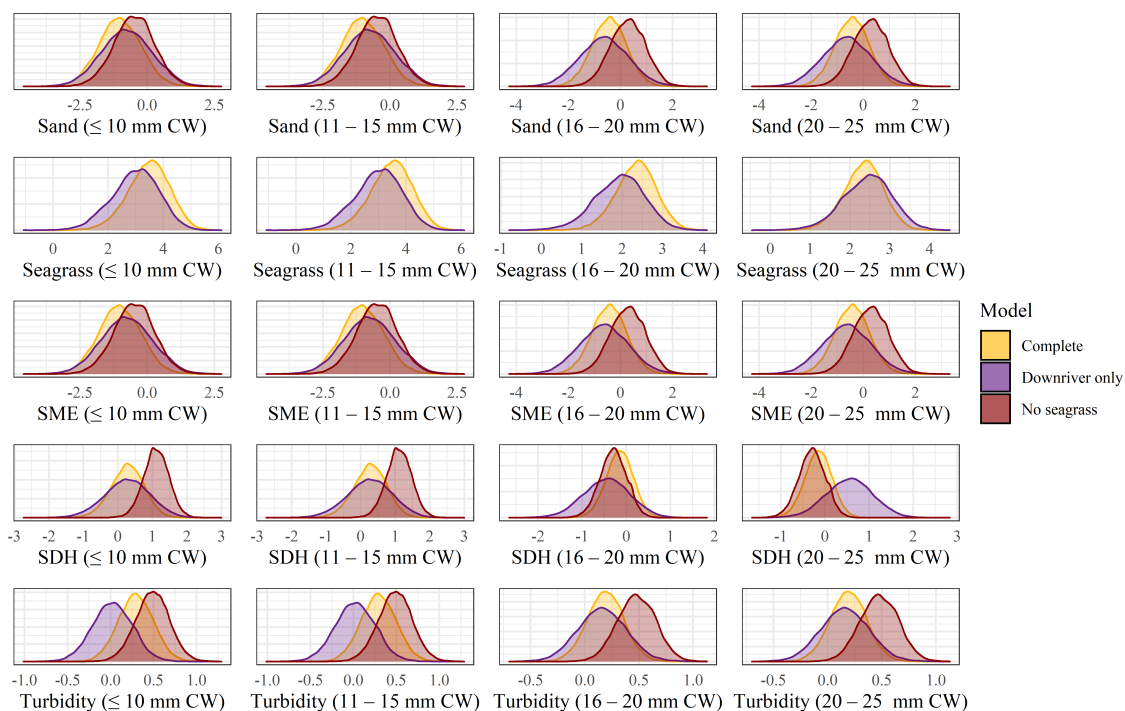


Fig. S3: Posterior distributions of regression coefficients from the selected model g_1 using the complete data set (Complete, yellow), and subsets of the data using only the downriver stratum (Downriver only, purple) and without seagrass (No seagrass, maroon). Posterior distributions were largely consistent across models, indicating inferences on the complete data set were robust.

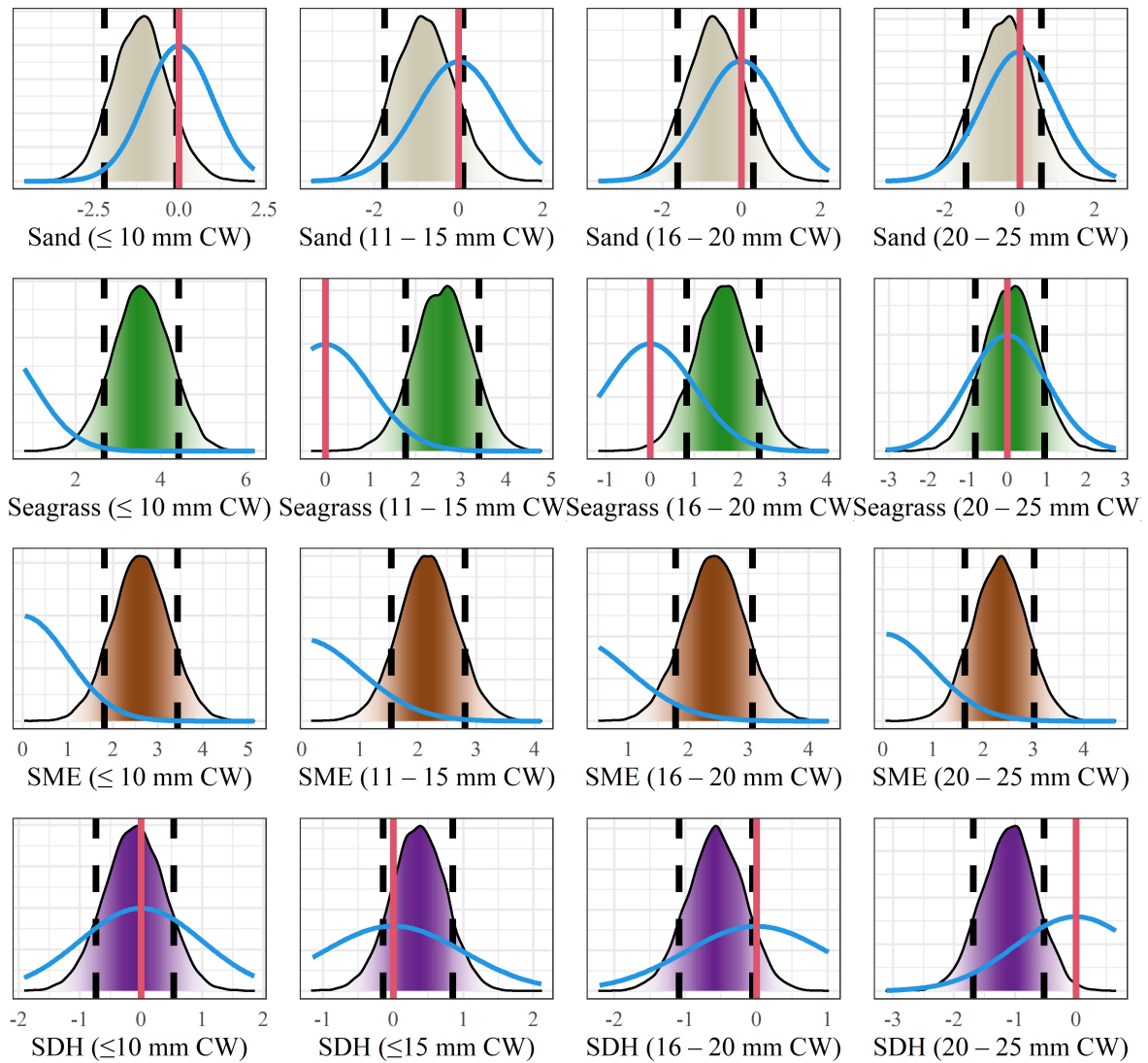


Fig. S4: Conditional posterior distributions of \ln mean habitat-specific abundances (conditioned on holding \ln turbidity and random effects at 0) from model g_1 for all size classes. Dashed black lines denote 80% Bayesian confidence intervals, while red lines (where present) denote 0. Blue lines depict prior distributions.

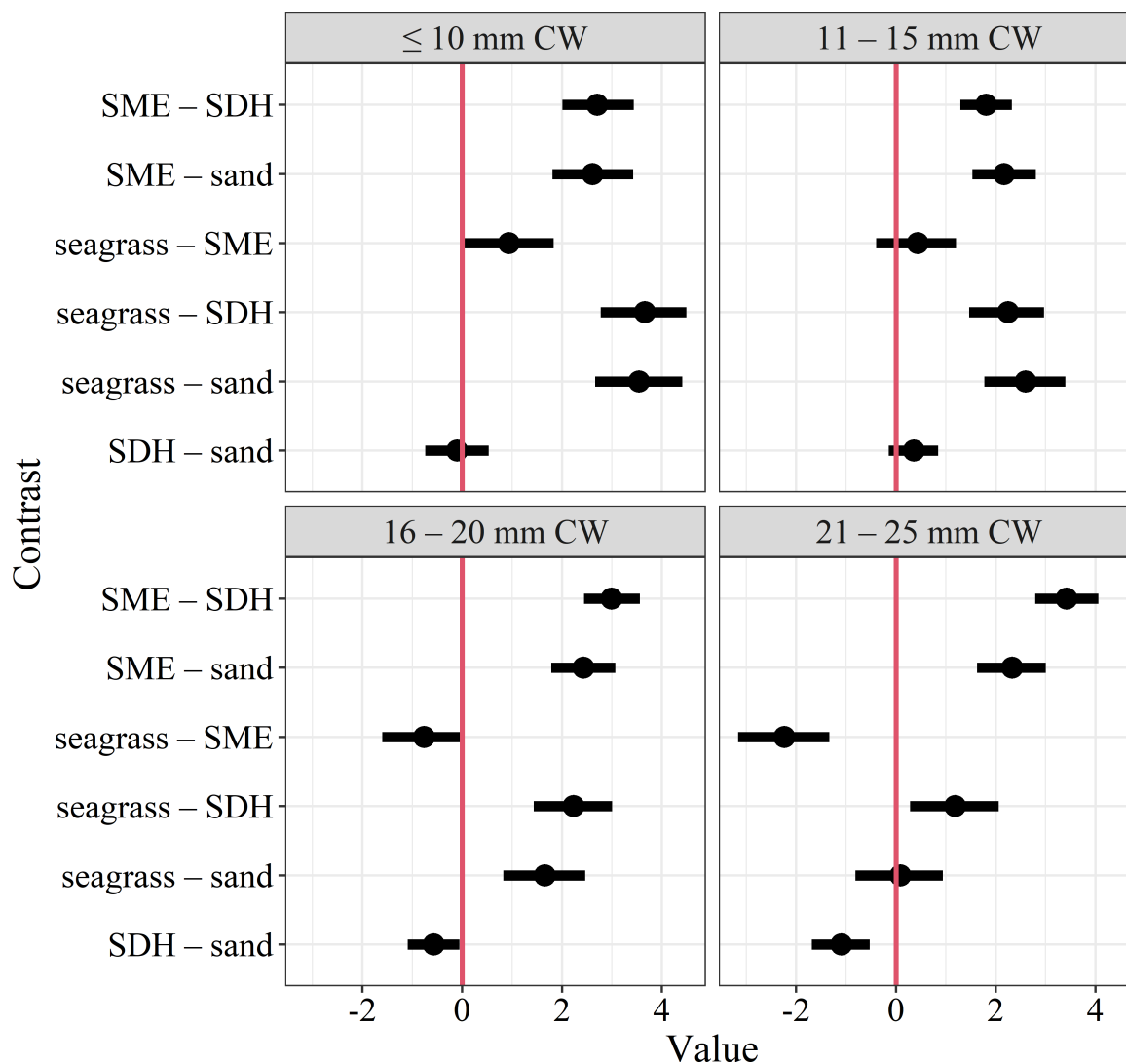


Fig. S5: Linear contrast statements (conditioned on holding \ln turbidity and random effects at 0, see Section 3.3.4) depicting differences in \ln expected juvenile blue crab abundance for all the size classes from Model g_1 . Dots denote posterior median difference in \ln expected values, while thick bars represent 80% Bayesian CIs.

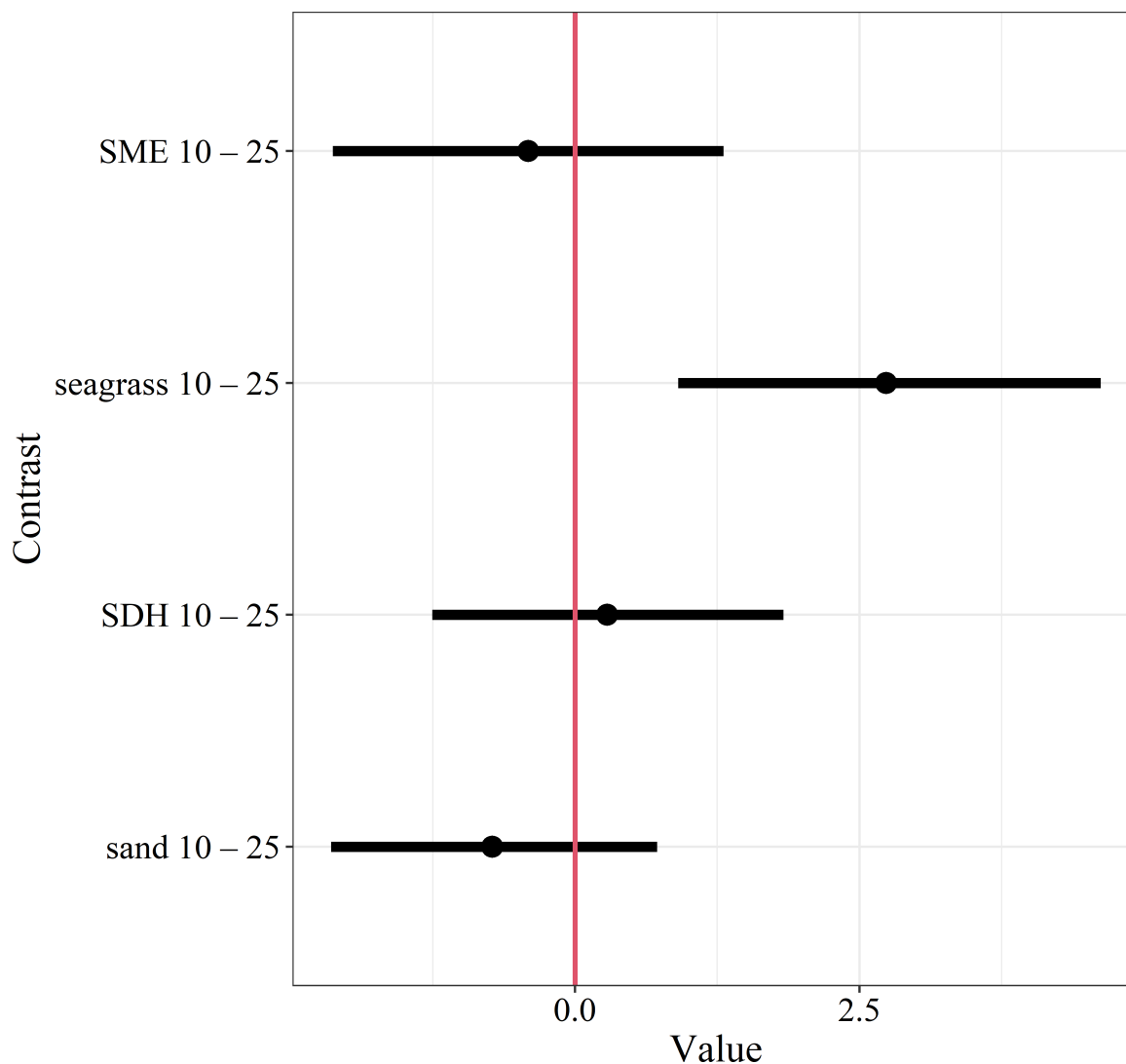


Fig. S6: Posterior distributions of within-habitat linear contrasts (i.e. the density of the smallest size class minus the see conditional density of the largest size class, conditioned on holding \ln turbidity and random effects at 0; see Section 3.3.4). Positive values indicate decreases in expected density as nominal size classes shift from ≤ 10 mm to 21–25 mm (i.e. more ≤ 10 mm than 21–25 mm individuals), while negative values indicate increases in expected density (i.e. less ≤ 10 mm than 21–25 mm individuals).

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