Summary of Natural Science Investigations:

Birds in Marshes

Project Activity: To determine whether constructed living shorelines are functionally equivalent to natural fringe marshes with respect to heron and shorebird use.

Objective: Due to increasing sea level rise, landowners attempt to prevent property erosion through various means ranging from shoreline armoring (bulkheads and rip-rap walls) to greener alternatives including constructed living shorelines (CLS). CLS are thought to provide habitat for herons and shorebirds, but this has not been previously evaluated. Here we compare heron and shorebird use between CLS and natural fringe marshes (NFM).

Methods: We used video cameras and acoustic recorders to sample marsh use by herons and shorebirds in 2018 and 2019 at 13 site pairs, each consisting of one CLS and NFM, which allowed us to control for differences in environmental factors among pairs. We estimated diurnal use of CLS and NFM via video sampling. Depending on the length and configuration of the CLS, we placed between two to four cameras at each marsh but kept the number of cameras the same within a pair. Each day of survey, we programmed the video cameras to record four 30-minute segments overlapping with heightened bird activity. We surveyed each site between one to three times from May until August each year, or in total between 13 to 50 hr per marsh across both years. We scanned videos and measured total time a given heron or shorebird species was observed in each 30-min segment. To avoid double sampling, we estimated total time spent in marsh by only using video from the camera nearer to an individual.

Great Blue Heron foraging at a natural fringing marsh on 6/4/19

Great Egret recorded at a constructed living shoreline on 5/14/19

We estimated diurnal-nocturnal use via acoustic recorders. We placed one recorder at the land-marsh ecotone and the center of each CLS and NFM. We recorded vocalizations for 10-min every two hours for 24 hr on two separate days during the breeding season between May and August. In total, we surveyed each site for 8 hr across both years. We hand coded presence/absence of heron and shorebird vocalizations because machine-learning algorithms failed to distinguish heron and shorebird vocalizations from non-target species.

We analyzed treatment effects on the basis of mixed-effects Bayesian regression analyses to address nested structure of data and spatial autocorrelations (distance among pairs). We used a negative binomial error structure to model time spent by herons and shorebirds at CLS vs NFM sites. We included marsh type nested within pairs as random factors (intercepts only) and treatment, year, marsh length, and sampling effort (total video hr multiplied by number of cameras) as factors. We analyzed acoustic data by estimating probability of detecting a given heron and shorebird species at CFS vs NFM sites. We omitted three pair sites for this analysis as distance between CLS and NFM was < 200 m, thereby rendering assignment of a heron or shorebird to a given CLS or NFM site impossible. We used a logistic error structure to estimate probability of detection. We included survey nested within marsh type and pair as random factors (intercepts only) and included treatment and year as factors.

Results: In total, we detected four heron, four shorebird, and one rail species, but detections varied with sampling method. On the basis of video sampling, we detected four heron and one

of four shorebird species. In contrast, we detected three of four heron and four of four shorebird species with acoustic recording, other than the Great Egret whose vocalizations were difficult to discern acoustically from those of the Great Blue Heron.

Diurnal use: We observed 84 individuals in six species across sites for a total of 9.5 hours, which was about 1.5% of the total video footage evaluated (677 hr). We found Spotted Sandpipers and Green Herons spending considerably more time at CLS sites compared to NFM sites. However, Great Blue Herons, Great Egrets, and Yellow-crowned Night Herons were indifferent in their use of marsh type (Fig. 1).

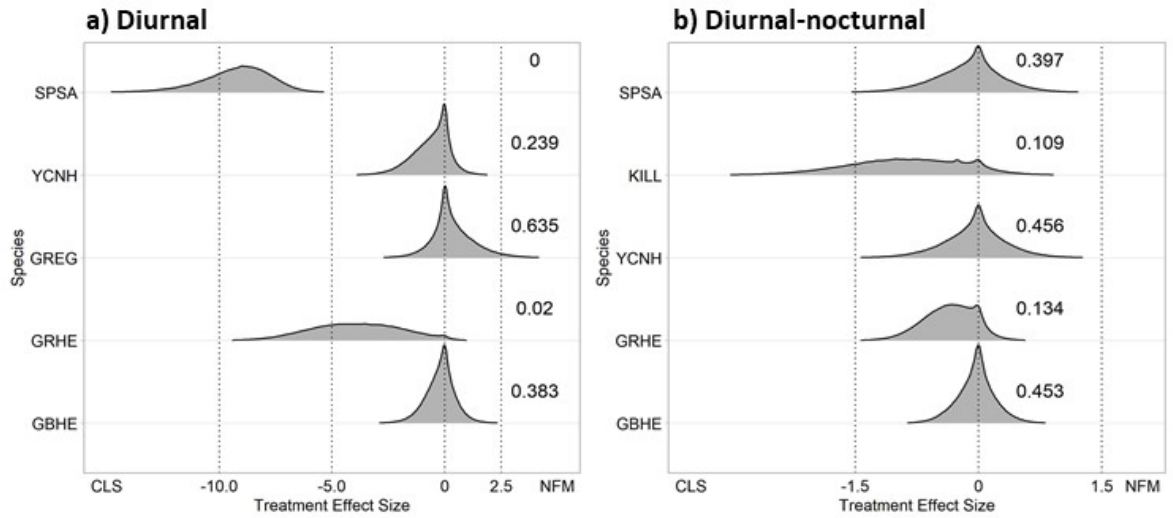

Figure 1: Posterior distributions of treatment effects and posterior probabilities for four heron and two shorebird species for two sampling approaches: a) Diurnal (video sampling) and b) Diurnal-nocturnal (acoustic recording). A value of 0.5 indicates equal use of CLS and NFM, whereas a highly positive or negative value would indicate that a given species used NFM or CLS sites more frequently, respectively. Great Blue Heron (GBHE, Ardea Herodias*), Great Egret (GREG;* Ardea alba*), Green Heron (GRHE;* Butorides virescens*), Yellow-crowned Night Heron (YCNH;* Nyctanassa violacea*), Killdeer (KILL;* Charadrius vociferus*), Spotted Sandpiper (SASP;* Actitis macularius*).*

Diurnal-nocturnal use: We detected at least one heron or shorebird species in 31.5% of 10-min sampling sessions (n = 960). We found agreement between two sampling methods for marsh type use for two heron species. The Great Blue and Yellow-crowned Night Heron were indifferent in their use of marsh type (Fig. 1). However, there were also notable differences between methods. For the two species where we found more frequent use of CLS sites when evaluated with diurnal data, the diurnal-nocturnal data revealed that Spotted Sandpiper used both marsh types equally and that there was only a trend for the Green Heron to use CLS more frequently. We also detected a trend for the Killdeer, a species not detected in diurnal sampling, to use CLS more frequently than NFM.

Conclusions: Our research indicates that CLS function equivalently to NFM for three of four heron species. However, our research suggests that marsh use varies depending on sampling design for one heron and shorebird species. For these species, diurnal sampling revealed more frequent use of CLS, whereas use was indifferent when evaluated with diurnal-nocturnal data. Overall, our research shows that CLS provide additional habitat for herons and shorebirds and are indeed an ecologically valuable alternative to other shoreline armoring.