Task 3

Project activity: Assessing habitat provisioning of living shorelines for birds breeding in salt marsh

Objective: Salt-marsh bird populations are decreasing across North America. Many factors contribute to this decline, but marsh loss and fragmentation are considered most important. Marsh loss and fragmentation occurs when land owners attempt to prevent property erosion due to sea –level rise by armoring shorelines. There are many types of shore-line armoring ranging from highly invasive rip-rap walls to less invasive living shorelines. In theory, living shoreline are thought to provide some habitat provisioning for salt-marsh birds but this has not been evaluated. Here we compare marsh-bird diversity of living shorelines with natural marshes.

Methods: We assess marsh-breeding bird diversity by sampling each pair of living shoreline and natural marsh three times during the breeding season between mid-May and end of June. Each sampling occasion consists of 48 10-minute sampling sessions that are scheduled to occur every 30 minutes within a 24 hr period. Sampling across 24 hours allows us incorporate differences due to tidal cycles and bird activity patterns. For example, song birds vocalize during early to mid-morning but also 1 to 2 hours before sunset. In contrast, wading birds may use living shorelines and fringe marshes any time during the day or night depending on tides.

We use an acoustic recording device called a Wildlife Acoustics Song Meter SM4 to record vocalization activities. Acoustic recording equipment is affixed to a wooden post placed at the center of the living shoreline or natural marsh. We program recording equipment to allow for at least one hour of lag between installation setup and the first recording. This timing prevents potential biases associated with equipment setup displacing birds from living shoreline or natural marshes.

We will use software, trained to recognize sound wave profiles of species sampled, to derive species-level presence/absence data. Software will be trained on the basis of sound recording collected from our study. We will test accuracy of software output with data collected by experts.

We will use occupancy modeling to explore variation in marsh-breeding bird occupancy adjusted for imperfect detection. Variation in occupancy will be related to local variables (area of fringe marsh and living shoreline, ecotonal type and extent) and variables representing marsh and terrestrial land cover extent and degree of fragmentation within average home range size of marsh breeding birds.

Progress to date: We have collected data on 13 paired sites during three sampling occasions between mid-May and early July, 2018. In total, we have 624 hours of recording. Initial screening of audio recordings revealed that vocalizations of both song and wading birds are captured. The audio recordings concurrently capture the sounds of local boat traffic, which we will use to evaluate whether boat traffic negatively affects wading bird occupancy.

Task 3

Project activity: Investigating Foraging Behavior of Wading Birds on Living Shoreline and Natural Fringing Marshes

Objective: To determine for wading birds whether living shorelines provide similar foraging habitats as do natural fringing marshes. A more comprehensive understanding of how wading birds—a top link in the food web of coastal salt marsh ecosystems—use natural fringing marshes and living shoreline marshes will assess the functional equivalency of living shoreline marshes relative to natural marshes and help to evaluate their viability as a management tool to combat the effects of rising sea levels and increased coastal erosion.

Methods: We have been using programmable wildlife video cameras to capture wading bird abundance and foraging behavior on the two types of marshes. In living shorelines, there are at least three cameras placed per marsh; one at each end of the living shoreline facing inwards, and one at the margin between the high and low marsh facing out into the water. The footage from this camera will also be used to assess boating activity at these marshes. Several of the living shorelines are large enough to merit one or two additional cameras between the two end cameras as well. The cameras are placed on the rock sill, facing down the length of the sill. In the natural fringing marshes, the cameras are placed to face along the front edge of the *Spartina alterniflora* zone. The length of each shoreline under video survey is determined in GIS, and we have tried to make the lengths surveyed as equal as possible between pairs of living shoreline and natural marshes. Each day of survey, the video cameras are calibrated to record four 30-minute segments when wading birds should be most active: an hour after sunrise; high tide; low tide; and an hour before sunset.

Progress to date: Data collection is an ongoing process (but will hopefully be finished by the August 16 meeting). As of the time of the meeting, we will have visited each site at least twice, for a total of four hours of footage per site. We have anywhere from 3-5 cameras recording at each site. There have been significant difficulties with the cameras in two major areas that prevented visiting each site three times. The first is that, over time, the cameras became more and more unfocused, which made some of the footage virtually unusable. The second is that there were problems with the recording script, which caused the cameras to capture incomplete video footage at the sites. To address the first issue, we have super-glued the lenses several times, wrapped each camera individually in bubble wrap before leaving to sample, and taken alternate routes that are less bumpy for the cameras. To address the second issue, we have re-written the script so that it is more convenient and less prone to error.

Task 3

Project activity: Determining the local and regional factors driving the population dynamics of a salt marsh obligate butterfly, the Salt-marsh Skipper (*Panoquina panoquin*)

Objective: Fragmentation poses a severe and urgent threat to biodiversity across many taxonomic groups. The impacts of fragmentation, namely the loss, conversion and isolation of habitat patches, often work synergistically to modify the functional connectivity of a landscape. Reductions in connectivity have been linked to movement impediments across a range of taxa including birds, mammals, insects, and plants. This trend extends to the dispersal dynamics of Lepidopterans (butterflies and moths) more specifically, where the degree of landscape fragmentation is often an important predictor of spatial population structures. Most published studies on fragmentation and connectivity were conducted in inland landscapes, predominantly disturbed by anthropogenic land-use conversion. By comparison, the terrestrial cover types of coastal systems may be fragmented by the complimentary effects of sea level rise in addition to upland development. Bilkovic et al. (2009) predict that this environmental interaction will magnify the loss of low-elevation tidal salt marsh in the lower Chesapeake Bay where rates of sea level rise are roughly 2.5 times the global average. The Salt-marsh Skipper (*Panoquina panoquin*), a specialist butterfly, is expected to be highly sensitive to the loss of these coastal wetlands. This rarely-studied grass skipper lays its eggs exclusively on Salt Grass (*Distichlis spicate*), a resident of the high elevation zones of tidal salt marshes. To understand how this species is currently distributed throughout the greater Hampton Roads region, and to model how it might be impacted by habitat loss in the future, we plan to survey the Salt-marsh Skipper, in addition to the broader coastal butterfly community, across a gradient of spatial landscape settings. We will then use these trends in patch use to estimate the species' future distribution and population dynamics under various projections of coastal landscape fragmentation.

Methods: In 2018, the butterfly communities of 25 tidal salt marshes will be surveyed nine times throughout the summer flight period of the Salt-marsh Skipper (late-May to early-September). Surveys will be hierarchically structured, such that sites are sampled on three successive days (secondary sampling occasions) once every 4 to 6 weeks (primary sampling occasions) to accommodate for the simultaneous estimation of detection probability (how likely are we to observe the skipper during each visit?) and site occupancy (given imperfect detection, what is the probability that at least one Salt-marsh Skipper is present during the primary sampling occasion in question?). This sampling structure will also allow us to calculate coarse estimates of butterfly dispersal throughout the landscape over the duration of the flight period. During each secondary sampling occasion, the surveyor walks a 250 m transect through the high marsh (determined according to grass community composition), taking note of any butterflies or nectar sources (forbs) observed every 10 m. If the transect exceeds the high marsh extent of a site, the surveyor walks the balance of transect along the terrestrial edge of the marsh. When a butterfly is observed, the surveyor records the species, sex (when possible) and behavior, including the species of butterfly, grass, or nectar source that the individual may be competing, or interacting with. This behavioral data will give us insight into how the Salt-marsh skipper uses a particular patch of salt marsh, and how intra- and interspecific competition may be structuring their regional distribution.

Progress to date: The first primary is complete, and sampling for the second primary should be completed prior to August 12th. A 30 m transect was used during the first primary based on observations made last summer that, when present, the Salt-marsh Skipper is abundant. We decided to lengthen the transect to 250 m for all future primaries, starting with the second, to increase the probability of detecting butterflies when they are more diffusely distributed within a marsh. This transect length is also more consistent with similar studies in the literature.