FinalProject\_WriteUp

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**OUTLINE**

INTRO: (SR) - NTB is commonly used in ecology to describe and understand biodiversity and evolution patterns (Rosindell et al., 2011; Wootton, 2005) - Generally: NTB is for theoretical scenarios, rather than as a predictive model - Also, NTB is not commonly applied to marine systems -Cite the few papers that do deal with NTB (Alzante; Borthgaray et al., 2009; Dolan et al., 2007) - Here we’re looking to: - Use NTB and competitive theory to evaluate how theoretical populations of shellfish will change over time under these scenarios in an estuary system -What does increasing immigration of a rare species do to the biodiversity of the system? (i.e. species introduced from aquaculture or invasive)

Section 1:(PJ) - What is NTB? (maybe Clark?) - What is competitive theory? (need papers)

Section 2: (SR) - System description: introduction of oysters and increases in green crab populations - Methods -NTB -Competitive

Section 3: -Prelim results from models

Section 4: - Discussion around special considerations for marine systems (Chust et al., 2016) -Refutes NTB (Dornela et al., 2006) -What about different dispersal rates? (Srisvastava and Pavel, 2013) - How does the scale of observation influence model results? (Chisholm and Lichstein, 2009) -What about harvesting activity? How does that play into the NTB model? -How does genetic manipulation from AQ influence biodiversity? -Connolly et al., 2014 -What worked and didn’t work

## WRITE UP

**Introduction**

Hubbell’s neutral theory of biodiversity and biogeography highlights the importance of unifying ecological processes–birth, death, and immigration–and offers a null model that can provide insight into current and future species-abundance distributions. Neutral theory is commonly used in ecology to describe and understand biodiversity and evolution patterns, and although its applications are expanding, it primarily supports theoretical exploration (Rosindell et al., 2011). Although neutral theory had been applied in the marine context (see Alzate et al., 2019, Dolan et al., 2007, Wootton, 2005, among others), it is not commonly used in marine ecosystems or for species that are targeted by marine fisheries. In this study, we seek to explore how neutral theory can be used to understand biodiversity patterns in intertidal marine ecosystems, with a focus on commercially important shellfish species. We will compare the neutral theory model to a competitive model and assess how well each model represents biodiversity patterns in a marine ecosystem. Specifically, we will model the biodiversity patterns that occur under immigration pulses from rare species. This approach aims to model recent species introductions observed in many of Maine’s intertidal marine ecosystems, namely the introduction of wild American oysters and increases in invasive green crab populations. This study will inform future analyses and help to identify potential forces driving biodiversity patterns in these systems.

**Study System**

The Damariscotta River estuary, located in midcoast Maine, hosts a diversity of coastal marine habitats ranging from rocky shores to soft sediment intertidal areas and eelgrass beds. The estuary is home to extensive human activity, including recreational boating, commercial fishing, and shellfish aquaculture. The Damariscotta has more than a dozen marine aquaculture operations that total 0.93 km², where farmers grow American oysters, mussels, scallops, and kelp (Maine DMR, 2022). The biodiversity in the Damariscotta is similar to other estuaries in the Gulf of Maine and varies along habitat type and physical and biological gradients (Britsch, 2021).

The intertidal mudflat is the focus of this study. This habitat hosts a diversity of shellfish, marine worm, and arthropod species. Of commercial interest are soft-shell clams (*Mya arenara*), quahogs (*Mercenaria mercenaria*), razor clams (*Ensis directus*), blood worms (*Glycera dibranchiata*), and sand worms (*Nereis virens*). Within the past 20 years commercial shellfish harvesters have observed the appearance of wild American oyster (*Crassostrea virginica*), a previously extirpated species now reappearing ostensibly as a result of aquaculture activity (Delago, 2021; Risley, 2022). Green crabs (*Carcinus maenas*), an invasive species originally from the Mediterranean, have also experienced a recent growth in population abundance, likely linked to warming ocean temperatures. Green crabs prey on shellfish species, particularly the delicate soft-shell clam, and have resulted in declines in clam populations as their number grow (Tan and Beal, 2015).

Therefore, the Damariscotta has two ‘rare’ species whose growth and expansion could effect the biodiversity of the whole system. This study seeks two explore how increases in rare species, like the wild American oyster and the green crab, can influence biodvisity within the ecosystem.

**Methods**

For this project we will use R Studio to simulate both a neutral theory model and a competitive model for the system. (Describe methods in-depth here once executed) - Create simulated log-series data - Run neutral model to completion - Run neutral model, halt, amplify rare speciese and run to completion - Run competition model to completion - Analyze SADs

**ADD CODE BELOW SO FIGURES CAN BE IN SINGLE DOC** *look at old spatial analysis Rmd for how to hide code in knit*

**References**

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