Evaluating reproductive timing, population genetics, and disease load in Texas oysters

Progress report

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Project Description

Both reef restoration and aquaculture of oysters benefit from an understanding of the local wild population. For restoration purposes, an understanding of genetic population structure, levels of genetic diversity, disease loads, and timing of reproduction are necessary to match wild and augmented oysters and to maximize the effectiveness of habitat restoration. For commercial aquaculture, this same information helps to minimize aquaculture-wild interactions and inform broodstock sourcing, farm stocking decisions, and farm-siting policies.

Methods

Wild oysters were sampled monthly from October 2023 to September 2024 from eight bays along the Texas coast. Sample locations were in the Lower Laguna Madre, Upper Laguna Madre, Corpus Christi Bay, Copano Bay, Aransas Bay, San Antonio Bay, Matagorda Bay, and Galveston Bay (Figure 1).

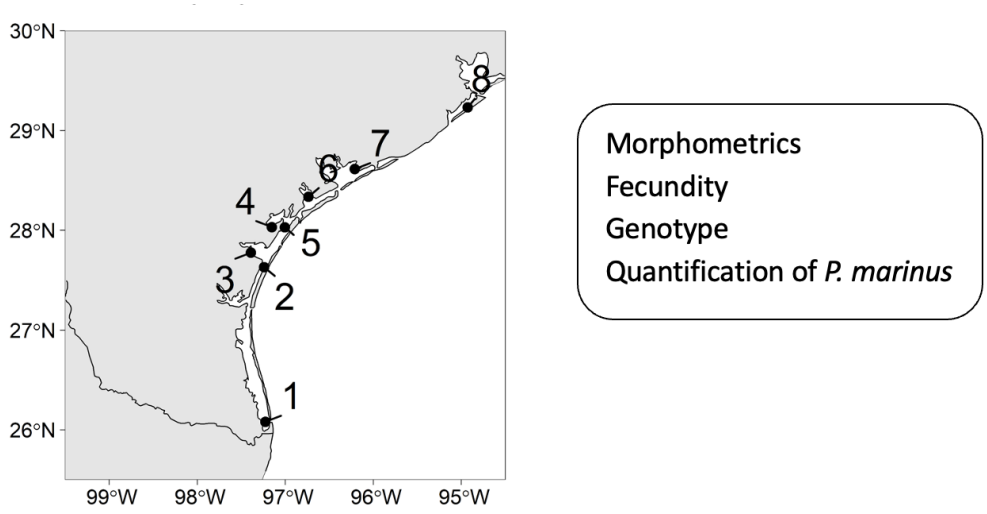

Figure 1: Locations of monthly oyster sampling (left) and data to be collected (right). 1 = Lower Laguna Madre, 2 = Upper Laguna Madre, 3 = Corpus Christi Bay, 4 = Copano Bay, 5 = Aransas Bay, 6 = San Antonio Bay, 7 = Matagorda Bay, 8 = Galveston Bay. Morphometrics refers to total live weight, shell length, and meat weight.

For the Lower Laguna Madre and Galveston Bay, one site was sampled throughout the project. From all other water bodies, oysters were regularly sampled from two sites (See Table A1 in Appendix for information on all sites). Fifteen to twenty five oysters (two inches or larger) were sampled from each site per month. During each site visit, salinity and temperature were recorded using a portable YSI sonde.

Sampled oysters were processed at the Texas A&M AgriLife Research Mariculture Center in Flour Bluff, Corpus Christi. For each oyster, fouling organisms were removed, then total live weight and shell length (maximum distance between the hinge and bill) were measured. The flat shell of was then removed (shucked), and the oyster was drained of its liquor by placing it flat-side down on a mesh net. After 10 minutes, both the flat shell and cupped shell containing the oyster meat were weighed to get the combined shell weight and meat weight.

The mantle and gill of each oyster were then swabbed to collect cells of the oyster as well as any cells of *Perkinsus marinus* that may be present. Oysters were then classified as male, female, or neither from a biopsy of the tissue. If sperm or no gametes were found, the gonad was sampled by making several incisions with a scalpel and rinsing the dissected material into a beaker. The sample of gonad was used to confirm sex and measure sperm activity. Sperm activity was measured with a 0-5 scale, 0 being no activity. If female, the gametes were collected by stripping them from the tissue via many incisions into the gonad with a scalpel. Fecundity was estimated for each female oyster by counting eggs in sub samples of a known volume.

After sampling or stripping the gonad, the remaining tissue of each oyster was removed from the shell and discarded. The flat and cupped shell were given 10 minutes to dry on a mesh net, then weighed. This shell weight was subtracted from the combined shell weight and meat weight to get a meat weight for each oyster. Fecundity of each female was calculated by dividing the total number of eggs by the meat weight of each oyster.

Results

We have organized the data into an interactive web application using the Shiny package in R. We are currently working on making this application available online, allowing users to access and use it directly through a web browser.

Currently, we have data on morphometrics (total live weight, shell length, meat weight), sex ratio, fecundity

of females, and sperm activity. We are in the process of collecting the genetic data and disease burden data (more in **Upcoming Developments**).

Below are highlights from the available data. The figures are screenshots from the interactive application.

1) Oysters from the southern region had females with eggs in December and January when no eggs were found in oysters from the most northern sites (Figure 2).

- The finding aligns with our experience that oysters in the Laguna Madre often have gametes in the winter, when oysters from more nothern sites tend to be reproductively dormant.

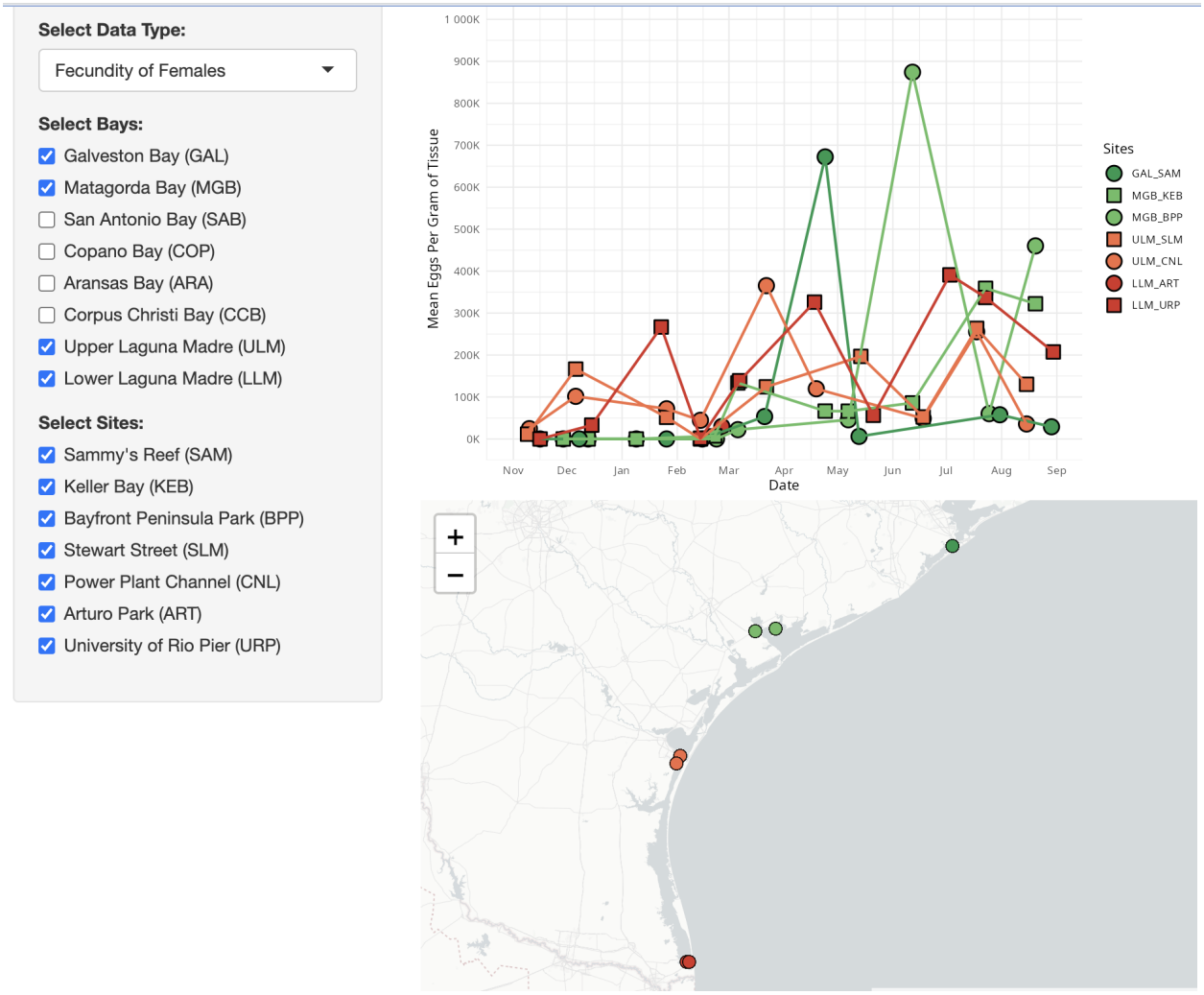

Figure 2: Mean number of eggs per gram of oyster tissue for females collected in Galveston Bay, Matagorda Bay, Upper Laguna Madre, and Lower Laguna Madre. If no females were found, mean fecundity was set to 0.

2) Female oysters in Galveston Bay reached peak fecundity in April, while females in Matagorda Bay reached peak fecundity in June (Fig. 3). Additionally, females from the two sample sites in Matagorda Bay reached peak fecundity at slightly different times (Fig. 4).

- The different timing of peak gonad development both between bays and within a bay suggests local environmental conditions strongly influence reproductive timing. For hatcheries, the observations highlight the value of holding broodstock in multiple locations to have access to ripe broodstock at various times of the year.

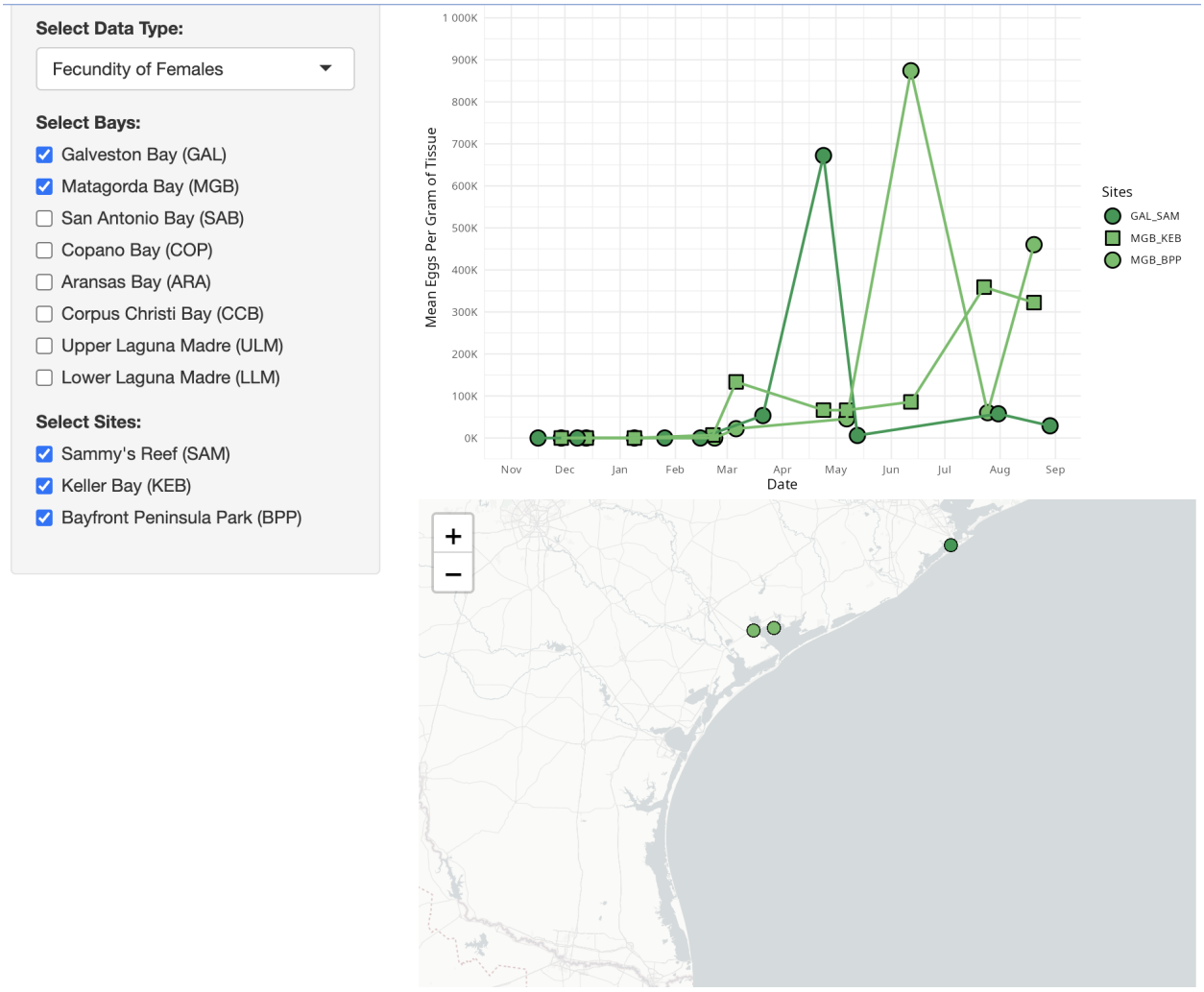

Figure 3: Mean number of eggs per gram of oyster tissue for females collected in Matagorda Bay and Galveston Bay. If no females were found, mean fecundity was set to 0.

3) Female oysters from one of our Matagorda Bay sampling locations, Keller Bay, had major changes in mean fecundity between May and August (Fig. 4).

- The data suggests the oysters at Keller Bay developed mature gonads within a month, then spawned within a month, then produced mature gonads again within a month, signifying the oysters can quickly produce gametes in certain conditions.

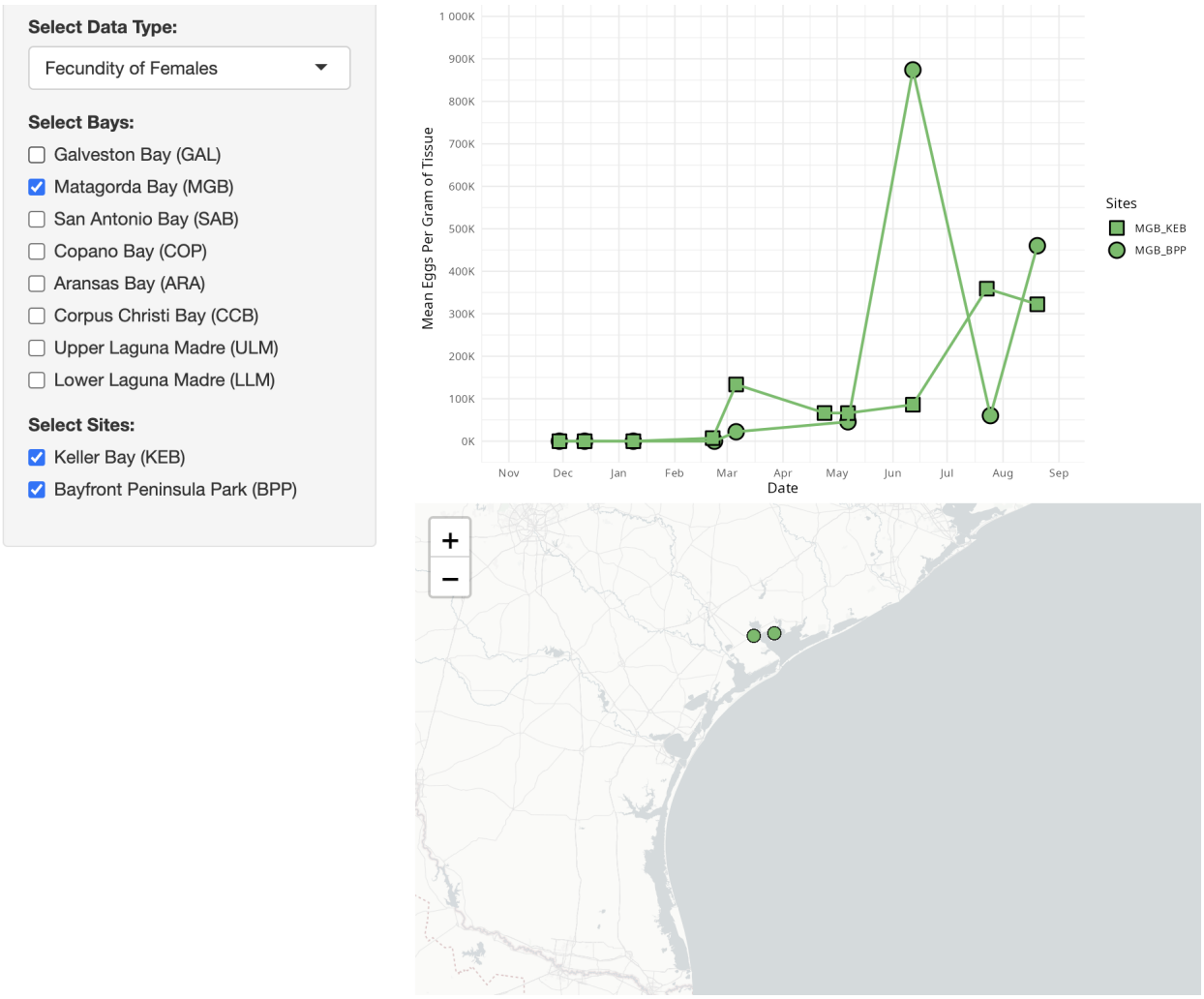

Figure 4: Mean number of eggs per gram of oyster tissue for females collected in Matagorda Bay. If no females were found, mean fecundity was set to 0.

Upcoming Developments

Morphometric and fecundity data

- We are currently processing oysters from our final collection effort of year 1. We plan on including the fecundity data in the interactive app once it is available.

Genetic analyses

- We are in the process of genotyping all oysters collected in April (n = 188) for the first look at the genetics of oysters at all our sampling sites. We expect to have the genetic analysis completed this fall.

Disease burden

- We are currently developing a quantitative PCR assay for *P. marinus* at Texas A&M University - Corpus Christi that will allow us to measure the number of cells of the pathogen in a sample.

Remaining priorities

Genetic analysis of oysters among bays

An important outcome of this project are data on the genetic profile of oysters within each bay system. From a year of collections, we have collected a sufficient number of samples to develop a robust dataset on the genetics of oysters along the Texas coast. We plan on genotyping oysters from our April 2024 and September 2024 sampling as an initial analysis.

Disease burden

Another major objective of the project is to evaluate differences in disease load, measured in concentration of *P. marinus* cells in our samples, among oysters collected along the Texas coast. We are developing the genetic tools in-house so we can measure the number of *P. marinus* cells from our samples. We then plan on measuring the disease burden across all sites from samples collected during the late fall, the expected peak of disease pressure.

Multivariate analyses

A key result of the project will be an analysis of the relationship among the location of collection, reproductive status, genetic profile, and disease burden of our samples. Evaluating these relationships requires multivariate analyses. A current masters student at Texas A&M University - Corpus Christi will be performing these analyses as the subject of their thesis.

Appendix

Table A1: Name of water body, name of site, latitude of site, longitude of site, and total number of oysters sampled per site throughout the survey as of September 2024. LM = Laguna Madre.

water_body	site_name	latitude	longitude	total_sampled
West Galveston Bay	Galveston	29.255477	-94.918502	205
Matagorda Bay	Keller Bay	28.636502	-96.450971	165
Matagorda Bay	Bayfront Peninsula Park	28.616436	-96.621993	135
Matagorda Bay	Indianola near La Salle Monument	28.527830	-96.508935	15
San Antonio Bay	Seadrift Jetty	28.404607	-96.710533	134
San Antonio Bay	Bill Sanders Park	28.390129	-96.709002	165
Copano Bay	North Lyndon Johnson Bridge	28.135193	-97.010290	165
Copano Bay	South Lyndon Johnson Bridge	28.112879	-97.026268	150
Aransas Bay	Mesquite Street	28.066811	-97.035140	150
Aransas Bay	Rock Port Pier	28.019186	-97.050716	135
Corpus Christi Bay	Nueces Bay Causeway	27.85256	-97.35965	133
Corpus Christi Bay	Cole Park	27.776309	-97.391421	30
Corpus Christi Bay	TAMUCC University Beach	27.715694	-97.322250	120
Upper LM	Stewart Street	27.659654	-97.270640	150
Upper LM	Channel Behind Flour Bluff Hatchery	27.604726	-97.305939	150
Lower LM	Arturo Park	26.078559	-97.220726	37
Lower LM	University of Texas Rio Grande Valley	26.073777	-97.200911	212