ANNUAL REPORT TO TRIUMPH GULF COAST INC.

Project #69: Apalachicola Bay System Initiative (ABSI)

Awardee: Florida State University

Reporting Period: March 15, 2020-March 14, 2021

ABSI LEADERSHIP TEAM

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REPORT OVERVIEW

The Apalachicola Bay System Initiative comprises a number of deliverables, each of which has a timeline for completion over the duration of the award. These deliverables are summarized below (Table 1). Some of the deliverables comprise multiple parts; for example, Experimental Ecology includes a number of research studies, but others are very specific, such as the population genetic study. This report presents accomplishments for the second year of this large multi-disciplinary effort and encompasses incomplete objectives from year 1. Discrepancies between target and completed deliverables are addressed. In addition, there is a section on personnel hires and other items that are not directly associated with the specific objectives.

Table 1: *Summary of timeline for project deliverables.*

Project Deliverables Timelines	Yr-1					Yr-2					Yr-3					Yr-4					Yr-5				
Assess temporal and spatial changes in status of oyster communities																									
Construct a pilot-scale oyster hatchery																									
Bio-physical modeling																									
Monitoring of oyster communities and their environment																									
Oyster population genetic structure																									
Experimental ecology																									
Coupled Ecosystem-Life History model																									
Management and restoration plan development																									
Targeted outreach to the community																									

In March 2020, Florida State University initiated restrictions on personnel access to laboratories and offices as safety precautions against Covid-19 transmission. Those personnel that could work from home were allowed to do so, with restricted hours if there was insufficient desktop work for full time employment. These restrictions significantly impacted our ability to work on some of the ABSI deliverables, particularly those that required personnel to conduct fieldwork or laboratory analyses. Work on the hatchery was also impacted as access by contractors and FSU hatchery personnel was limited. In May, field and laboratory work was allowed to resume with stringent Covid safety precautions including limited personnel in the offices, labs and vessels. Over the summer, FSUCML initiated regulations that would allow laboratory access, and by the beginning of 2021, activities were allowed to resume, with safety precautions, at a functional capacity. Despite these restrictions, ABSI made progress on a number of deliverables and has established several new studies during the past year, as well as expanded our virtual outreach efforts.

PROJECT OBJECTIVES FOR YEAR 2

1. **Assess temporal and spatial changes in oyster communities in Franklin County (continuation from year 1)**

This objective was initially planned for year 1 only, but since there is no end point for gathering supporting information and data, we will continue to work on this objective throughout the life of the project. We have continued to gather historical and contemporary sources for data on oyster reef distribution, reef associated fish and invertebrate communities, oyster ecology and biology, and environmental conditions within Apalachicola Bay and adjacent waterways. This information has provided a baseline from which to evaluate changes observed during ABSI, and help generate target metrics for future restoration and management decisions

Deliverables for this component include a database with information on spatial and temporal changes in oyster reef distribution, productivity and environmental conditions. Digital GIS-based maps and reports will be available through the project website and updated annually.

Accomplishments during year 2

We continue to update the literature database, which currently has more than 325 reports, peer-reviewed manuscripts, maps and data sets which have been assimilated and catalogued into a number of different categories (ecology, ecosystem services, environmental conditions, genetics, hydrodynamics etc.). Historical environmental data, oyster population data, and fisheries independent monitoring data for non-oyster species have been obtained from different sources (ANERR, FDACS, FWC, manuscripts and reports) and have been incorporated into a number of ArcGIS layers for integration into a number of web-based products. This deliverable is still in development as we are continuing to produce a series of compelling and interactive data products that will provide public access to complex information. The optimal platform for most of this information is the ArcGIS-based story map (https://storymaps.arcgis.com/), which can be used to combine maps with text, images and data. To accomplish this, FSUCML has obtained access to the FSU online ArcGIS account, and over the past summer, we have created the first story map of a historic timeline of the Apalachicola Bay, which can be accessed through the ABSI website community engagement page (https://marinelab.fsu.edu/absi/commengage/)

Additional web-based products will show spatial and temporal patterns in environmental conditions using long term environmental data from a number of sources. This is expected to be available soon through our website. Another product in development is a story map of historical through contemporary bathymetry and oyster habitat distribution, showing changes in available habitat over time.

Discrepancies between proposed and actual deliverables

There are no specific discrepancies between proposed and actual deliverables, we have been working on creating engaging public-facing products from our data and literature and have several more in progress.

2. Construct a pilot-scale oyster hatchery (continuation from year 1)

The construction of a research oyster hatchery is a critical component of the ABSI; however this was estimated to take more than 2 years. In order to expedite some of the hatchery tasks, the FSU matching infrastructure funds covered the cost of a small interim hatchery to support operations while the permanent hatchery is being constructed.

Accomplishments during year 2

The interim hatchery was completed in September 2020 and comprises a broodstock conditioning room housed in a modified laboratory, a 50 x 30 ft greenhouse for spawning and larval culture and two large setting tanks, fed with raw seawater for larval settlement and spat grow-out. the first spawning was attempted on October 6, 2020 but unfortunately this effort did not result in egg release, so no larvae were produced. We are currently conditioning oysters collected from Apalachicola Bay and will attempt our first major spawn on April 5th. We have obtained and conditioned oyster shell to set the larvae and will use the resulting spat on shell for restoration experiments to be deployed in late spring 2021.

The permanent hatchery will be housed in a 50 x 70 ft metal building (to avoid some of the temperature problems encountered with the greenhouse) and will replace two existing CML greenhouses. The plans for the permanent hatchery have been completed and approved by Triumph, the old greenhouses removed, and construction contracts have been approved. Construction will begin as soon as final permits are in place and is expected to be operational before the 2022 spring spawn.

Discrepancies between proposed and actual deliverables

The interim hatchery was on schedule to be operational for the spring 2020 oyster spawn; however, due to the Covid-19 restrictions, completion of the hatchery was slowed considerably due to staff and purchasing limitations. The interim hatchery was operational in September 2020.

3. Bio-physical modeling

Freshwater flow dynamics is being addressed through a 2-year consultancy contract with Dr. Steve Leitman with the following objectives: 1) Develop a set of metrics to define optimal management of the watershed with regards to sustainable ecological productivity of both the river and estuarine aquatic resources; 2) Examine potential modifications to the current Water Control Manual operations, taking into account the metrics developed in objective 1; 3) Test current and proposed revised operations against alternative climate scenarios with regard to changes in both the volume of water being delivered to the river and estuary and the timing of rainfall events; 4) Encourage an adaptive management approach based on the outputs from the objectives above.

Bio-physical modeling of the ABSI system is being conducted by Dr. Steven Morey, a physical oceanographer at Florida Agricultural and Mechanical University (FAMU), and his post-doctoral researcher Dr. Xu Chen. Specific objectives of this work are: 1) Configure a hydrodynamic model for the lower Apalachicola River, Apalachicola Bay and the surrounding coastal and inner shelf regions (including Cape San Blas through Cedar Key, FL) based on the latest bathymetric and topographic data; 2) Run hindcast and future climate and management scenario simulations, incorporating flow inputs from Dr. Leitman's model; 3) Perform analyses of the simulations to characterize the variability of hydrographic properties throughout Apalachicola Bay; 4) Using a

numerical particle tracking approach to simulate oyster larvae, conduct and analyze larval transport simulations to quantify factors such as larval recruitment, retention and inter-estuarine exchange.

Freshwater dynamics will be combined with near-shore coastal hydrodynamic models to create a composite physical flow model for the ABSI region and beyond. Physiological data from oyster larvae (produced by the hatchery) will be incorporated into the physical oceanography model, to create a tool for estimating dispersal pathways and predicting connectivity among oyster populations. The final deliverable is an integrated model that combines habitat distribution, water flow and larval dispersal data to predict oyster recruitment patterns under different climatic regimes. Interim products include models of freshwater flows under management and climate scenarios, and hydrodynamic models of water flows into, around and out of the ABSI area.

Accomplishments during year 2

Dr. Leitman, has been using a Stella river-basin model, to define a range of freshwater flow scenarios under varying climatic regimes and management practices. Below is a summary of accomplishments since March 2020.

1. Completed the calibration of the ACF STELLA model with the U.S. Army Corps of Engineers (ACOE) HEC Res Sim model under the current operating rules for the basin and received approval from ACOE head of reservoir operations.
2. Evaluated performance of the Water Control Manual under 100 different realizations of the historic climate and provided results to the ACOE.
3. Initiated work on two technical papers for publication: 1) the evaluation of the Water Control Manual under alternative realizations of the historic climate and 2) the extent which flows in the Apalachicola River and into Apalachicola Bay are driven by management of the ACF basin's storage reservoirs and by climate.
4. Defined riverine metrics to be used in modeling evaluations and initiated work on defining estuarine metrics to evaluate alternative operations of the ACF reservoir system, including the development of a web-based program to evaluate alternative operations.
5. Initiated evaluation of alternative operations of the ACF reservoir system.
6. Made several presentations on this project to the ABSI Community Advisory Board

Dr. Morey brought Dr. Xu Chen into the coastal hydrodynamic modeling project as a post-doctoral scientist in July 2020, initially through FSU and subsequently at Florida A&M University. Dr. Chen's focus has been on the tasks associated with the first project objective of configuring a hydrodynamic model, specifically, developing an improved bathymetry dataset and developing a refined grid version of FVCOM simulation. The refined versions of the hydrodynamic model have undergone testing for computational timing and preliminary assessment with observations.

The unconstructed mesh grids for the FVCOM simulations are generated based on high-resolution bathymetry from NOAA with modification from the UF team. The mesh is configured with high resolution near features such as coastlines, oyster habitats, ship channels, and steep bathymetry slopes. Bathymetry of river channels and distributaries south of Sumatra including the Brothers river are corrected using a 3m-resolution sonar data from recent river surveys in

2020 and 2021 obtained through collaboration with Jiahua Zhou, Ken Jones, and Scott Walls. Two versions of the model grid have been developed: one with a highly refined mesh to simulate flow through the river and distributaries entering Apalachicola Bay and another reducing the domain size and resolution to 30m for faster computational speed. This second domain runs fast enough to be used for scenario simulations with freshwater inputs parameterized for multiple distributary sources based on results from the higher resolution mesh and communication with Ken Jones. The simulation is nested within the Navy Research Laboratory HYCOM Gulf of Mexico nowcast/forecast system to provide initial conditions and boundary conditions with tides. Initial scenarios are being run with historical forcing (boundary, surface, and riverine flow) for assessment. At this time, all scheduled tasks have been completed for 2020 and work is currently focused on running and assessing model hindcasting, which is expected to be completed on schedule (end of July 2021)

Discrepancies between proposed and actual deliverables

No significant discrepancies exist between proposed and actual deliverables for the freshwater modeling. For the coastal hydrodynamic model, Dr. Xu Chen was hired as a Research Associate (postdoc) at Florida A&M University on 9/4/20. Dr Chen was previously at FSU and began work on the ABSI project on 7/1/2020. The initial project schedule anticipated hiring this position on 1/1/2020. The delay was due to Dr. Chen, the leading candidate for the position, being committed to an existing project early in 2020 and subsequent delays in position creation and hiring due to COVID restrictions. The project is a little behind schedule on developing the oyster larvae modeling component, but that is expected to be ready for preliminary analysis by October 2021.

4. Monitoring of oyster communities and their environment

Intertidal oyster populations have received relatively little research and monitoring attention in the ABSI region. Consequently, we do not have a good understanding of the temporal and spatial dynamics of oyster populations in intertidal habitats or their contribution to overall larval supply. The ABSI intertidal monitoring plan involves collecting information that is similar to subtidal data collected by FWC. In combination these data sets will provide a comprehensive overview of oyster populations in the ABSI study area. Deliverables from this objective include (but are not limited to): 1) databases containing environmental data; 2) monitoring data (including recruitment rates, juvenile survival and growth, adult size and abundance, and incidence of predators, parasites, and diseases) from a series of intertidal locations throughout Franklin County.

The FWC oyster team surveys specific subtidal reef areas monthly using SCUBA and obtains density samples from these sites twice annually. This effort generates a valuable dataset that shows trends over time in the same locations but does not provide a broad view of the oyster population status across the Bay. In October 2020, ABSI partnered with a former Apalachicola oysterman to survey subtidal oyster reefs throughout Apalachicola Bay using small oyster tongs. This sampling approach is faster and can be done in more inclement conditions that SCUBA diving. These data will be used to guide placement of restoration experiments and guide ecological studies to understand the observed patterns of distribution

The ANERR has five YSI Exo2 data sondes deployed in Apalachicola Bay; these instruments collect *in situ* data on temperature (^{o}C), salinity, conductivity (mS), dissolved oxygen (%, mg/L) pH, turbidity (NTU). To provide a broader spatial understanding of environmental conditions,

ABSI planned to deploy additional instruments of the same type. Data from all of these instruments will be used to interpret ecological data, and to inform and ground-truth the hydrodynamic model. These data will be made available to the public once we develop a platform to allow easy access.

Accomplishments during year 2

Intertidal oyster surveys

Intertidal oyster reef monitoring continued with only a short lapse in April 2020 due to covid-19 safety restrictions (Table 2). Four areas were repeatedly sampled for oyster size, reproductive condition, disease, and recruitment: Alligator Harbor (AH), Carrabelle River (CR), East Cover/East Slough (EC), and St. Vincent Island /Indian Lagoon (IL). Five sites at each area were sampled for a total of 20 sites. A total of 34 sampling trips were completed, representing wide spatial-temporal coverage. Oysters from each site were subsampled to measure disease prevalence and reproductive condition. In total, 142 oysters were tested and indicated that disease prevalence is low in intertidal oyster populations. 195 spat traps were deployed in conjunction with sampling efforts to estimate oyster recruitment. In November and December of 2020, all 20 reefs were sampled for oyster density, as well as the standard monthly sampling metrics. These density samples match those taken by FWC for the subtidal reefs.

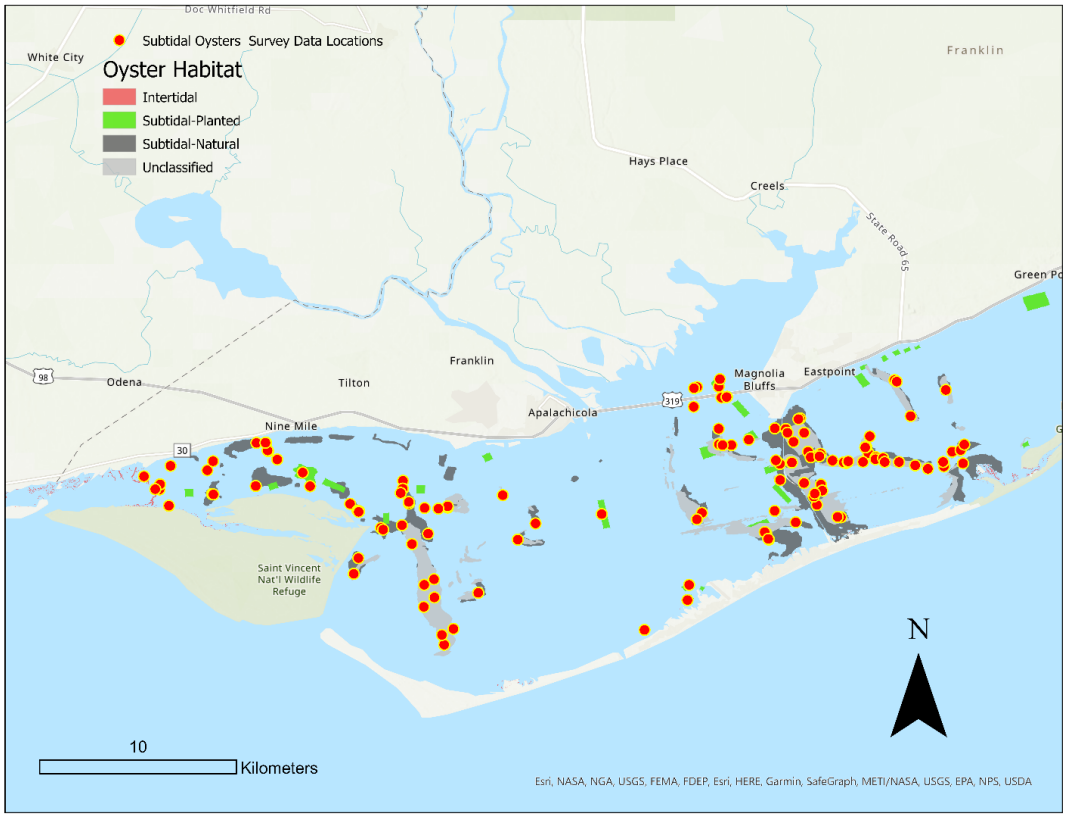
Table 2. *Intertidal monitoring sampling in Alligator Harbor (AH), Carrabelle River (CR), East Cover/East Slough (EC), and Indian Lagoon (IL) Sampling = collection of 15 oysters per site for condition index, reproduction and disease. Spat traps = monthly deployment/recovery to assess recruitment. *Density sampling occurred in addition to regularly scheduled sampling.*

Sample Date	Site	Sample Date	Site
3/10/20	AH	9/2/20	AH
3/10/20	CR	9/10/20	IL
3/30/20	IL	9/23/20	CR
5/13/20	AH	10/1/20	EC
5/20/20	IL	10/14/20	AH
5/27/20	CR	11/4/20	IL*
6/10/20	EC	11/19/20	AH*
6/16/20	AH	12/1/20	CR*
6/24/20	EC	12/10/20	EC*
6/24/20	IL	12/15/20	IL
7/1/20	CR	1/14/21	AH
7/8/20	CR	1/20/21	CR
7/8/20	EC	1/26/21	IL
7/22/20	AH	2/3/21	EC
7/29/20	IL	2/10/21	AH
8/12/20	CR	3/2/21	CR

Subtidal oyster surveys

The objectives of these surveys was to (1) prioritize areas for more detailed mapping efforts, (2) locate sites for oyster reef restoration experiments, (3) refine the current understanding of the extent of oyster reefs in Apalachicola Bay, and (4) detect patterns in live oyster density. Between 10/13/20 and 3/16/2021, 132 sites across Apalachicola Bay were surveyed between 10/13/20 and 3/16/2021 (Fig. 1).

Figure 1: *Map of subtidal reef survey locations.*



At each station, six replicate single tong samples are taken from the bow, middle and stern of both sides of the vessel. The following parameters were recorded for each tong sample: volumes of total material, shell (non-living), live oysters and rock; numbers of spat (less than 25 mm), sub-legal oysters (25 mm – 75 mm), market-sized oysters (greater than 75mm), and boxes (dead, articulated shells). In addition, history of cultch planting and type of cultch (shell, limestone, fossil shell) planted. These subtidal surveys indicate that the current distribution of oysters populations in Apalachicola Bay is spatially patchy and sparse. There are very few areas that support market sized oysters, and those areas with significant numbers of live oysters were generally those that were recently planted (2017-2019) with limestone, particularly in the eastern part of the bay. ABSI is currently planning field experiments that will test and quantify these patterns with statistical certainty. Data collected during the subtidal surveys is being used in the site selection process. The subtidal sampling with continue monthly (or as weather allows) by

sampling a number (to be determined) of randomly selected locations over historical reef areas across the Bay. By visiting different sites each time, the data will provide an broad view of the status of oyster populations in the Bay over time.

In situ instrument deployment

ABSI has deployed six multiparameter sondes (YSI EXO2) strategically throughout Apalachicola Bay (Fig. 2) to address previously identified information gaps and provide a more complete overview of the ABS water quality parameters. Each instrument is equipped with sensors to collect hourly *in situ* data on temperature (ºC), salinity, conductivity (mS), dissolved oxygen (%, mg/L) pH, turbidity (NTU). Instruments were wrapped in copper tape and sensors surrounded by copper mesh cage to prevent fouling; however they will be examined bi-monthly for fouling. Data download and cleaning will also occur on this schedule and these data will be used to inform bio-physical modeling, GIS-based maps, and experimental ecology. ABSI will also contribute these data to collaborators such as ANERR, FWC and it will be made available to the public through a web-based platform.

Table 1. *Summary of multiparameter sonde deployment dates and locations throughout the ABSI study area*

Deployment Date	Latitude	Longitude	Area/Site Description
29 December 2020	29.63285	-85.08116	West Pass
29 December 2020	29.68502	-85.22139	Indian Pass
29 December 2020	29.72447	-84.98046	Apalachicola River
29 December 2020	29.70725	-85.11916	St. Vincent Sound
29 December 2020	29.72648	-84.80716	St. George Sound
17 February 2021	29.62703	-84.96905	Sikes Cut

Figure 2. *Distribution of instruments (YSI EX02) deployed by the Apalachicola National Estuarine Research Reserve (ANERR), Central Panhandle Aquatic Preserve (CPAP) and ABSI*

Discrepancies between proposed and actual deliverables

The April 2020 intertidal monitoring was omitted because of FSU Covid restrictions. Instrument deployment was delayed by ACOE permits and severe storms throughout the fall months of 2020

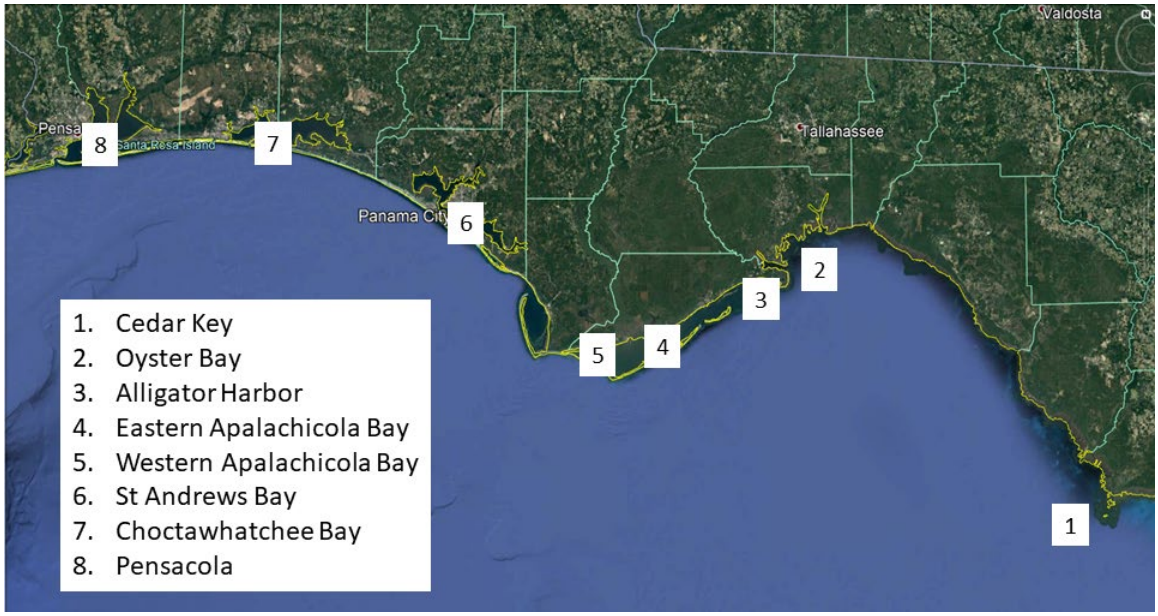
5. Oyster population genetic structure

Past research on population genetic structure of the eastern oyster indicated significant differentiation among sites across the Gulf of Mexico; for example, the northeast Gulf population (Anclote Keys to Mississippi River, approximately 800 km) is considered genetically different from the other regions of the Gulf. On a smaller scale, studies of oysters off North Carolina identified differences among populations north and south of the Pamlico Sound, a distance of less than 100 km. Population structure has not been studied within the northeastern Gulf of Mexico, but population differences are possible given the large number of embayments in the region. This component of the ABSI is intended to help identify distributions of oyster sub-populations, which has a number of important applications. Distinct sub-populations may have characteristics that enhance survival under particular environmental conditions. and thus could be used as different genetic lines of broodstock for restoration and aquaculture. With the expansion of aquaculture and importation of seed from elsewhere in the Gulf, it is important to understand local population structure so that genetic integrity (and therefore local adaptation) can be maintained. Analysis of population distribution will also help ground-truth connectivity predictions generated by the bio-physical model.

Accomplishments during year 2

This project was initiated in January 2021 through a contract with Dr. Amy Baco-Taylor, a population geneticist and faculty member within the Department of Earth, Ocean, and Atmospheric Sciences at FSU. This project will involve collecting a minimum of 30 samples from each of eight locations within and outside of the ABSI region (Fig. 3) The initial step of the processing for population genetics is extraction of DNA from each specimen to produce a genomic library. Microsatellites will be selected and amplified to provide initial data on population structure. An additional technique (RADSeq) will be explored to obtain higher resolution of relationships among populations and individuals. Sequences are analyzed with bioinformatic tools to reveal population genetic structure and connectivity among individuals. Expected completion of this work is December 2021.

Figure 3. *Sampling sites for oyster population genetic structure*



Genomic DNA has been successfully extracted from 182 oysters from sites 1, 3, 4 and 5. Of the available choices, 20 microsatellite loci were selected and tested on a small number of individuals, and 19 were considered suitable for further analyses. We are testing out the potential to multiplex PCR these loci and then will order appropriately labeled primers. The next step is mass-PCR of these markers in all individuals using the labeled primers. The RADSeq methods are also being explored as RADSeq methods are slightly more sensitive to population structure than microsatellites.

Discrepancies between proposed and actual deliverables

This project was supposed to begin in the 4th quarter of year 1 (January 2020), but contract development was delayed because of personnel availability, then in March 2020, Covid restrictions prevented access to laboratories, which is critical for this research. Once restrictions were lifted sufficiently, the contract was established, and work began.

6. Experimental ecology

This category includes several projects that are designed to help understand the ABSI system, with a view to identifying and addressing specific ecological problems. These projects are described below; some are continuations from year 1, but most were initiated in year 2.

Habitat suitability model for eastern oysters in Apalachicola Bay

This project was initiated in year 1 and is being conducted by Adam Alfasso, a Ph.D. student at FSU. The overarching project objective is to create a series of habitat suitability models (HSM's) for the eastern oyster, specifically within Apalachicola Bay. These models will describe the distribution (or probability of presence) of oysters in the bay, and will represent: 1) current distribution using recently collected environmental data and oyster presence, 2) past distribution (before the fishery collapse to earliest reliable conditions), and 3) future distributions based on modeled hydrodynamic and sea level rise scenarios. The model outputs will be used to understand how suitable habitat distribution has changed over time, and what it might look like in the future in order to guide and inform restoration and management efforts.

Accomplishments during year 2

The past year was spent gathering and combining datasets from multiple sources for testing with the initial modeling technique MAXENT. This endeavor has highlighted the shortage of high-resolution datasets of most types within this region, a problem currently being addressed by multiple research efforts as part of the ABSI. The preliminary goal was to create a streamlined process for processing environmental data layers as the products became available, which was achieved, and to create new spatially explicit, higher resolution environmental datasets, which is progressing but still ongoing.

Discrepancies between proposed and actual deliverables

None to report. This project is a PhD dissertation and the student is making good progress.

Apalachicola Bay food web and sediments: 1994-2020.

The principle investigator on this project is Dr. Jeff Chanton, a senior professor at FSU. The purpose of this research is to investigate changes to the Apalachicola Bay food web and carbon cycle with respect to a previous study conducted in the mid to late 1990's (Chanton and Lewis, 2002). The earlier study examined and quantified the relative importance of terrestrial versus marine carbon inputs to the bay. The goal the current study is to test the hypothesis that the bay has shifted rely more upon marine inputs relative to terrestrial carbon inputs due to waning freshwater delivery to the bay. Both studies rely upon variations in ^{13}C and ^{34}S values of the various pools examined. The values differ according to the relative inputs of marine and terrestrial carbon, with marine inputs being enriched in ^{13}C and ^{34}S while terrestrial inputs are depleted in ^{13}C and ^{34}S. The earlier study collected samples during periods of generally low river flow (September-November) and high river flow (April-June), to compare influence of seasonality on isotopic signatures. The current study is targeting a sub-set of the previous extensive sampling regime, and is focused on ^{13}C, ^{15}N and ^{34}S signatures in plankton, sediments,

fishes and oysters. These different components of the system will provide an indication of whether the system has shifted since the 1990's

Accomplishments during year 2

Collections of oysters and fishes was completed from similar locations to the previous study (Dry Bar and Hotel Bar) in the fall dry period, as well as plankton tow samples from similar locations as previously. Sediment samples (31) were collected from several north-south transects, from East Bay to across Dry Bar to compare to the earlier study values. Isotopic results indicate no shift in $d^{13}C$ that would be indicative of a decline in terrestrial inputs to the bay in either sediment or plankton samples. Fish and oyster sample analysis is in progress, and another series of samples are scheduled for collection in April 2021.

Discrepancies between proposed and actual deliverables

Due to permitting issues, collection of some of the fish species was delayed until later in the season, and some of the target species are less available in the Bay during the colder months. However, enough species were available in sufficient numbers to conduct the analysis.

Analysis of fish communities in Apalachicola Bay

This study used long-term monitoring data collected monthly by the FWC Fishery-Independent Monitoring Program to investigate spatial and temporal changes in finfish community structure in Apalachicola Bay and St. George Sound. The overarching objective was to determine whether annual river flow rates, or other environmental factors, are drivers of the observed patterns of community structure. These data were also used to determine whether there were serial changes in communities from 2001 to 2018 that might indicate a decline in 'health' of the Bay. The data set includes three gear types (21 m haul seine, 183 m haul seine, and 6 m otter trawl), and 175 species of fishes and commercially-important invertebrates such as blue crabs and shrimp.

Accomplishments during year 2

All analyses for this project have been conducted and a manuscript draft is in its second round of revisions with coauthors at FSUCML and FWC. The manuscript will be submitted for peer review by the end of April. Results of this study suggest evidence of changes in communities that may be related to drought/wet years, but that communities tend to rebound following these perturbed states. Fish communities in Apalachicola are seasonal and mediated primarily by temperature, and there are spatial differences in communities along gradients of salinity and water clarity. While direct effects of annual river flow rates were relatively low in our quantitative analyses, our results suggest fish communities in Apalachicola Bay and St. George are mediated by freshwater inputs which maintain spatial salinity regimes and gradients important in structuring through assemblages.

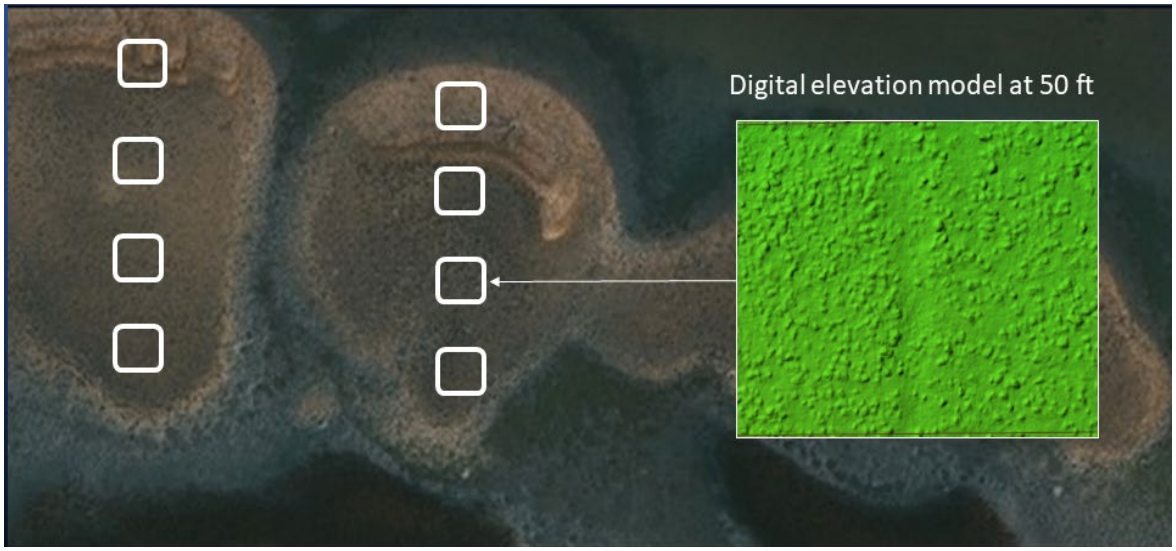
Discrepancies between proposed and actual deliverables

The project was due for completion by the end of 2020; however delays in obtaining data and dealing with additional statistical analyses recommended by internal reviewers have set the manuscript submission date back.

Intertidal habitat dynamics

This project is part of a MSc thesis for Jenny Bueno, an FSU graduate student who joined the ABSI team in September 2020. Jenny is a certified drone pilot and her work builds on the earlier drone data collected by Duke University in year 1. This study aims to use UAS (unoccupied aerial systems), also known as drones, to obtain remotely sensed data at intertidal oyster reefs in Apalachicola Bay, FL. Drones are a low-cost, repeatable, and timely method of obtaining high-resolution imagery (Windle et al., 2019). The imagery is then processed using a photogrammetric software that detects similar features between each image to create a point cloud. The point cloud is then used to create digital elevation models (DEMs) and orthomosaics. The DEM is a raster that is georeferenced and contains elevation data (Fig. 4). The orthomosaic is an image mosaicked together from the collected imagery, free from distortion. These products will be used to look at the condition of the reefs. Some of the variables that can be assessed using DEMs include reef-height and rugosity. Reef-height can indicate whether there is reef accretion or erosion over time, and rugosity can be used to evaluate surface complexity, which is indicative of higher live oyster presence (Rodney & Paynter 2006). These variables will be analyzed to assess spatial and temporal dynamics of oyster populations on intertidal reefs. Using remote sensing techniques is an alternative way to assess the condition and distribution of marine ecosystems. It is more cost-effective than in-person sampling and reduces habitat impact

Figure 4. *Orthomosaic of an intertidal reef in Alligator Harbor, created from drone imagery. Inset is a digital elevation model of a sub-sample of the reef. White squares represent quadrats placed on the reef to ground-truth the drone images.*



Accomplishments during year 2

Test flights have been conducted over several intertidal reefs to determine optimal flight height to generate images of sufficient resolution for analysis.

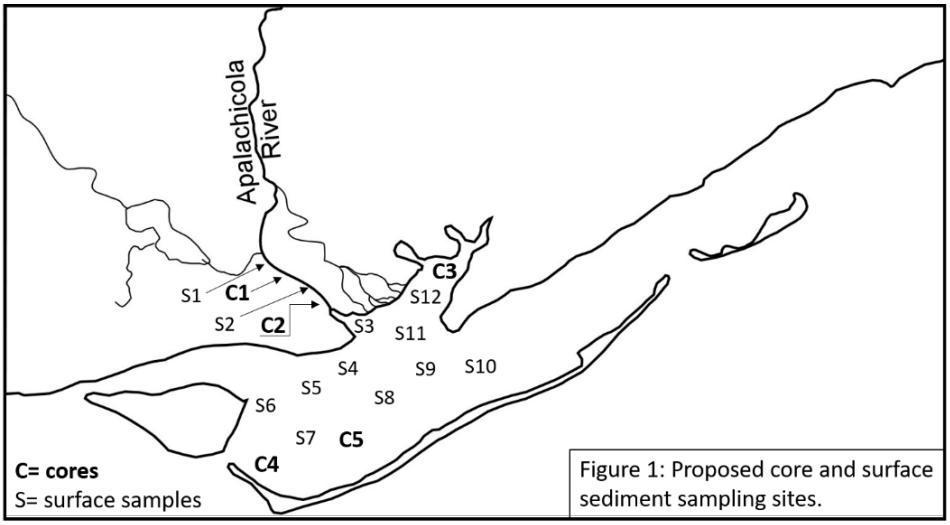
Discrepancies between proposed and actual deliverables

None to report

Pollutant distribution in Apalachicola Bay

In 2020, local community members expressed concerns that pollutants may be entering the Bay from upriver anthropogenic and natural sources. Shellfish can bioaccumulate some pollutants, such as heavy metals, creating a human health as well as ecological concern, and aquatic invertebrates are highly sensitive to some pesticides. In an earlier study (Apeti et al 2005), concentrations of 5 heavy metals (Copper, Zinc, Cromium, Cadmium and Lead) were measured in sediment from 6 locations within Apalachicola Bay, and a study of pesticides (organochlorines, organophosphates, Chlorinated phenoxy-acid, and polychlorinated bipenyls) in Apalachicola River sediments (Elder and Mattraw 1984) showed levels lower than would be hazardous to aquatic animals. These studies will serve as 'baseline' comparisons for new data. In early March 2021, ABSI subcontracted Dr. Michael Martinez-Colon from FAMU in a collaborative effort to understand the concentration and distribution of 5 metals/metalloids (Copper, Zinc, Nickel, Arsenic, Selenium), and 7 pesticides (Aldrin, Dieldrin, Endosulfan, heptachlor, Methoxychlor, Chlordante, DDT) in Apalachicola Bay sediments. Samples include surface sediments (12) to examine contemporary levels and sediment cores (5) to examine historical conditions. Sampling locations are shown in figure 4

Figure 4*. Sediment sampling locations for heavy metal and pesticide analysis across Apalachicola Bay. S1-12 = surface grabs, C1-5 = core samples.*



Progress to date

Samples have been collected and processing is ongoing

7. Targeted outreach to the community

The onset of the COVID-19 pandemic brought about a necessary adaptation in the ABSI outreach and engagement efforts. However, amidst travel restrictions and limited in-person meetings, ABSI's engagement with the public and local stakeholders not only survived but thrived. These engagement endeavors include (but are not limited to) the continuation of the Community Advisory Board, the development of an Outreach and Education Subcommittee and Successor Group Subcommittee, creation of a bi-monthly ABSI newsletter, partnership and

participation with local organizations to host virtual events, and an expanded website that houses research data and educational materials.

Accomplishments in Year 2

Community Advisory Board

The Community Advisory Board (CAB), led by *Florida Conflict Resolution Consortium* (FCRC) Consensus Center facilitators Jeff Blair and Robert Jones (ret. Jan 2021), has continued to flourish. The over-arching objective of the CAB is to develop and agree on overall ABSI goals, objectives, and timelines; to seek consensus on actions and options informed by science for restoring the health of the Apalachicola Bay ecosystem; and agree on an overall management and restoration plan for the Apalachicola Bay system. The 23 CAB members* represent local stakeholders, including watermen, local, state, and federal government officials and business owners, seafood and recreational fishing industry workers, and environmental groups.

**Due to time commitment issues, a few Board members stepped down and were replaced with members of similar stakeholder organizations.*

Community Advisory Board Membership summary

Agency personnel: Lee Edmiston *(Retired)* - Apalachicola National Estuarine Research Reserve, Former Reserve Manager*;* Jim Estes*- Florida Fish & Wildlife Commission Division of Marine Fisheries*,* Department Deputy Director*;* Tom Frazer - Chief Science Officer for the State of Florida*;* Jenna Harper - Apalachicola National Estuarine Research Reserve, Reserve Manager*;* Erik Lovestrand - Florida Sea Grant, Extension Director for Franklin County*;* Alex Reed - Florida Department of the Environment*,* Director of Office of Resilience and Coastal Protection*;* Portia Sapp - Florida Department of Agriculture and Consumer Services Division of Aquaculture, Director*;* Paul Thurman - Northwest Florida Water Management District, Environmental Scientist

Local government: Anita Grove - Apalachicola City Commissioner; Ricky Jones - Franklin County Commissioner

Local business: Chuck Marks - Acentria Insurance, Vice President; Mike O'Connell - Saint George Island Civic Club, 2025 Vision; Steve Rash - Water Street Seafood, Owner; John Solomon - Apalachicola Chamber of Commerce, Executive Director; Denita Sassor – Outlaw Oyster Company, Co-Founder

Non-governmental organizations: Georgia Ackerman - Apalachicola Riverkeeper, Executive Director; Chad Hanson - PEW Charitable Trusts, Fisheries Science and Policy Analyst

Non-profit organizations: Frank Gidus - CCA Florida, Director of Habitat & Environmental Restoration; Chadwick Taylor - Riparian County Stakeholder Coalition

Watermen: Chip Bailey - Peregrine Charters, Owner; Shannon Hartsfield - Waterman, Franklin County Seafood Workers Association; Roger Mathis - Waterman, R.D.'s Seafood; TJ Ward - Buddy Ward & Sons Seafood

**Jim Estes will be replaced by Alan Pierce, Florida Fish & Wildlife Commission Division of Marine Fisheries in May 2021*

The ABSI CAB web page contains detailed information on the CAB membership (https://marinelab.fsu.edu/absi/people/community-advisory-board/).

Development of Outreach and Community Engagement Subcommittee

Following the July 16th CAB meeting, a subcommittee of interested CAB members and ABSI project leaders met to discuss outreach and community engagement strategies. The Outreach and Community Engagement subcommittee was then formally formed in an effort to dedicate more time outside of regular CAB meetings to implementing outreach initiatives and events for the local community.

Subcommittee Meeting Dates:

August 4, 2020; November 19, 2020; December 15, 2020; January 20, 2021; March 2, 2021. (Agendas/Minutes found here: https://marinelab.fsu.edu/absi/cab/cab-subcoms)

Members of the Outreach and Community Engagement Subcommittee:

FSU: Felicia Coleman (ret. Dec. 2020), Sandra Brooke, and outreach assistant, Maddie Mahood

ABSI CAB: Chad Hanson (Chair), The Pew Charitable Trusts; Georgia Ackerman, Apalachicola Riverkeeper; Anita Grove, Apalachicola City Commissioner, Michael O'Connell, St. George Island Civic Club, 2025 Vision.

Initiatives developed by this committee:

- Development and distribution of a bi-monthly ABSI Newsletter (via email). Following each Community Advisory Board meeting, a newsletter is created summarizing the progress of the CAB, ABSI research updates, and upcoming events and education opportunities. The ABSI Newsletter email list currently has ~315 subscribers. Previous issues can be found here: (https://marinelab.fsu.edu/absi/commengage/newsletterarchive/)
- Development of a media distribution plan for the ABSI newsletter and additional updates
    - Every ABSI update and newsletter are posted on Florida State University Coastal and Marine Laboratory's social media outlets: Facebook (@FSUCML), Twitter (@FSUMarineLab) and Instagram (@fsumarinelab)
    - Initiated relationship with Michael Allen, Oyster Radio; Petra Shuff, Wakulla Chamber of Commerce; and Lisa Munson, Carrabelle Chamber of Commerce. Each of these organizations share the ABSI newsletter on their respective Facebook pages,
    - Subcommittee members share with their respective organizations' social media pages and newsletters, including Apalachicola National Estuarine Research Reserve, Apalachicola Riverkeeper, Apalachicola City Commission, Franklin County Commission, Wakulla Citizens group, Focus on Franklin County, as well their individual social media accounts.
- Development of public workshops are slated to begin in late April/May 2021. With spring weather moving in, the Subcommittee has brainstormed presenting to smaller public groups in an effort to maintain COVID-19 safety precautions and social distancing. The Subcommittee is currently finalizing plans to present to the St. George Island Civic Club.
- Participation in local virtual events and panels (see ***Virtual Events***)

Development of Successor Group Subcommittee

Following the November 12th CAB meeting, a Successor Group Subcommittee was formed in an effort to ensure the continuation of the work of the ABSI/CAB. The purpose of this Subcommittee is to develop a strategy to form a permanent, representative stakeholder successor group to advocate for the adoption and implementation of the restoration plan.

Subcommittee Meeting Dates:

February 2, 2021; February 23, 2021 (Agendas/Minutes found here: https://marinelab.fsu.edu/absi/cab/cab-subcoms/)

Members of the Successor Group Subcommittee:

FSU**:** Joel Trexler

ABSI CAB: Georgia Ackerman (Co-chair), Apalachicola Riverkeeper; Shannon Hartsfield (Co-chair), Apalachicola Seafood Workers Association; Jim Estes, FWC; Anita Grove, Apalachicola City Commission; Chad Hanson, PEW Charitable Trusts; Ricky Jones, Franklin County Commission, District 1; Steve Rash, Water Street Seafood; Chadwick Taylor, Riparian County Stakeholder Coalition.

CAB Meetings

All meetings since May 22, 2020 have been held virtually via Zoom. Documents from each meeting have been posted on CAB website, including meeting agendas, copies of meeting presentations, meeting summaries, and meeting video and audio recordings. (https://marinelab.fsu.edu/absi/cab/absi-cab-documents/)

May 22, 2020 presentations: 1) Overview of Oyster Management (J Estes, FWC), 2) FWRI Oyster Monitoring and Restoration Efforts in Apalachicola Bay (M Parker, FWRI Oyster Program), 3) MK Ranch Hydrologic Restoration (D James, Ducks Unlimited), 4) Lake Wimico (L Stevens, The Nature Conservancy)

July 16, 2020 presentations: 1) Oyster Modeling Demonstration (E Camp, UF), 2) Oyster Habitat Suitability Model (L Geselbracht, The Nature Conservancy and ABSI Science Advisory Board)

September 9, 2020 presentations: 1) The Role of the CAB and Scope of the Project (F Coleman, FSU), 2) CAB Outreach Subcommittee Report (F Coleman, FSU), 3) Apalachicola Bay Wild Oyster Harvesting Closure Briefing (M Norberg, FWC), 4) Model Status Update (E Camp, FSU)

October 15, 2020 presentations: 1) FWC Update on Apalachicola Bay Closure (J Estes, FWC), 2) Contrasts in Apalachicola River Discharge Create Opportunities for Learning (B Pine, UF and ABSI Science Advisory Board), 3) Update on Freshwater Inflow Modeling for ABSI (S Leitman, FSU)

November 12, 2020 presentations: 1) ABSI Science Update and Model Development (S Brooke, FSU), 2) ABSI-NFWF Shared Components and Restoration Schedule (F Coleman, FSU and J Estes, FWC)

January 13, 2021 presentations: 1) ABSI Science and Data Collection Update (S Brooke, FSU), 2) Apalachicola Bay Wild Oyster Harvesting Closure Update (J Estes, FWC), 3) Overview of

Apalachicola Bay Mapping Project (R Grizzle, Univ. of New Hampshire and ABSI Science Advisory Board)

February 24, 2021 presentations: 1) ABSI Science Update (S Brooke, FSU) 2) Apalachicola Bay Oyster Monitoring Program (M Davis, FWC), 3) Pensacola and Perdido Bays Estuary Program (M Posner and D Killorn, PPBEP)

Oystermen's Workshop

In an effort to involve the local community in ABSI management and restoration discussions, the ABSI held its first Oystermen's Workshop on December 2, 2020 at the Apalachicola National Estuarine Research Reserve (ANERR). To abide by COVID-19 safety guidelines, eight oystermen were invited to attend in-person, along with the ABSI project leads and facilitator, Jeff Blair. The members of the Community Advisory Board and public were invited to view the meeting via Zoom. The purpose of the workshop was to hear from oysterman on suitable locations and materials for restoration and on management alternatives. A recording of the meeting and full summary report can be found here: (https://marinelab.fsu.edu/media/4626/absi_oystermen_workshop_summary_report_2-dec-2020.pdf)

In-Person Attendees:

Oystermen: Michael Carmichael, Michael Dasher, Ronnie Gilbert, Shannon Hartsfield*, Brett Lolley, Roger Mathis*, Coy Shiver, Wayne Williams

ABSI Representation: Sandra Brooke, ABSI Principal Investigator; Joel Trexler, ABSI Co-Principal Investigator, Anita Grove*, Apalachicola City Commission

FCRC Consensus Center: Jeff Blair

*Members of the Community Advisory Board

A second Oystermen's Workshop will be held on Monday, April 15th at ANERR with the same COVID-19 safety guidelines in place.

Virtual Events

COVID-19 prompted a sharp increase in virtual webinars and presentations, and the ABSI has been fortunate to partner with local organizations to spread word of the project's progress and overall purpose. (https://marinelab.fsu.edu/absi/commengage/aboutoyster/absi-events/)

WFSU Perspectives – January 28, 2021

- Community Advisory Board members Georgia Ackerman, executive director Apalachicola Riverkeeper; Sandra Brooke, FSU Coastal and Marine Lab; Jim Estes, Florida Fish and Wildlife Conservation Commission fisheries researcher; Anita Grove, Apalachicola City Commissioner; Shannon Hartsfield, 4th generation Franklin County seafood worker; and Ricky Jones, chair, Franklin County Commission joined host Tom

Flanigan to talk about the Apalachicola Bay System Initiative, and what factors are impacting the loss of Apalachicola's world-famous oysters?

Apalachicola City Commission Meeting – February 2, 2021

- Sandra Brooke presented an update on the progress of ABSI to the Apalachicola City Commission. The presentation was well received and ABSI has agreed to present an update at the Commission meetings every couple of months.

ANERR Virtual Symposium – February 18 – 19, 2021

- ANERR hosted a two-day virtual science symposium free to the public to highlight all the research projects currently being conducted in the Apalachicola Bay System. Several different members of the Community Advisory Board and ABSI research teams presented their research.

ANERR Virtual SciCafé: Apalachicola Bay System Initiative – February 25, 2021

- Sandra Brooke provided an overview of ABSI and its purpose in partnership with ANERR's Virtual SciCafé series. Attendees (62) represented a broad cross-section of stakeholder groups (fishermen, business owners, NGOs, state agencies, etc.)

ABSI Website/Online Engagement

The ABSI has worked to improve the availability of information on the ABSI website. Information on research progress, Community Advisory Board meetings and documents, ABSI leadership and staff, and educational materials are present and updated on a regular basis. ABSI is trying new approaches to creating engaging outreach material. The use of ArcGIS StoryMaps is becoming increasingly popular as it is an effective community outreach tool. This interactive web-based map application allows the creator to display GIS-based maps with narrative text and other multimedia content in a dynamic format, and present complex analyses and concepts in a user-friendly format. ABSI has begun to create ArcGIS StoryMaps which will be published to the ABSI website.

Recently developed educational materials include:

- Historic timeline of the Apalachicola Bay System created via ArcGIS StoryMap (https://cosspp.maps.arcgis.com/apps/Cascade/index.html?appid=c015817d93104f7fb7cbc35ae0a993cf)
- Oyster Life Cycle animation (https://youtu.be/-yw2euo1Bo4)
- No Shell Left Behind: Bringing Shell Recycling Back to Franklin County report (https://marinelab.fsu.edu/media/4580/no-shell-left-behind.pdf) and ArcGIS StoryMap (https://cosspp.maps.arcgis.com/apps/Cascade/index.html?appid=e31ec37e7a574e229907f470254350d8)
- A Historical Oyster Map is in its final development stages and will be published on the website by mid-April. This will take users through a timeline of the ABS and encourage them to interact with maps that will display how the system has changed over time regarding water quality parameters and oyster coverage. Included GIS maps will dynamically display historic

oyster coverage and planted areas (1930-1985), river flow data (1999 – current), water quality data (1999 – current), and current oyster distributions from ABSI sampling. Each layer will have a time feature that will allow the user to scroll through time and see how each map changes throughout the years and will be accompanied by other supporting multimedia.

Shell Recycling Program

An assessment of the feasibility of developing a successful shell recycling program for Franklin County has been completed (*See No Shell Left Behind report above*). Staff at the Apalachicola National Estuarine Research Reserve (ANERR) and the Conservation Corps of the Forgotten and Emerald Coasts are in the process of developing an OysterCorps Pilot Program for oyster recycling in Franklin, Gulf and Bay counties with the Northwest Florida Water Management District and The Nature Conservancy's GulfCorps Program. ABSI and the Florida State University Coastal & Marine Laboratory (FSUCML) were invited to join them as a partner in November 2020. ABSI's Hatchery Manager, Joe Rocco, and Hatchery Technician, Shannon Kirk, have been working with the program managers to initiate the next steps of program implementation.

ABSI personnel changes in Year 2

ABSI Leadership

In December 2020, Dr. Coleman (Co-PI) retired from FSU and no longer works on the ABSI. In early 2021, Dr. Trexler moved to the FSUCML to take over as Director of the Marine Lab and he also replaced Dr. Coleman as project Co-PI. In January 2021, Dr. Ostrander stepped down as Vice President for Research to become a faculty member in the College of Medicine, but he remains engaged in the ABSI.

Additional Technicians

- *Eve Moore.* Works part time on ABSI to help with field-work and lab processing
- *Shannon Kirk.* Hatchery technician hired in August 2020 to help with hatchery operations
- *Kevin Englebert.* Partly funded by ABSI, hired in October 2020 as technician to Dr. Josh Breithaupt, ABSI research faculty

Additional FSU graduate students

- *Adam Alfasso,* Ph.D., Earth Ocean and Atmospheric Sciences: Predictive Habitat Modeling for oyster communities in the ABS
- *Jenny Bueno,* MSc Geography: Use of drones in assessment of intertidal oyster reefs
- *Emily Fuqua,* Ph.D Biological Sciences: Understanding mechanisms and drivers of heritability of phenotypic traits in the eastern oyster

ABSI Research Faculty

Dr. Josh Breithaupt (https://marinelab.fsu.edu/people/faculty/breithaupt/) joined the FSUCML on August 10th, 2020 as a member of the ABSI team. His research focuses on carbon, nutrients and sediment dynamics, and how these can be used to understand health and change in coastal

ecosystems. In the past six months he has begun work on several projects relevant to understanding ecosystem health and functioning in the Apalachicola Bay system:

- One of the uncertainties about oyster reef communities in the bay is the durability and fate of oyster shell. Dr. Breithaupt is initiating a system-wide research effort to quantify the rates of oyster shell dissolution in intertidal and subtidal habitats.
- A second project, related to the first, is examining sediment organic matter dynamics throughout the Bay. Sediment samples have been collected from the bottom of the Bay and analyzed for sediment organic matter and calcium carbonate content. These results are being compared with a similar mapping effort that was published in 1963. Additional work will be done to collect pore-water pH and microbial respiration measurements to determine the extent to which benthic sediment organic matter content is changing and whether it is influencing corresponding changes in bottom-water corrosivity for oyster shell.
- Dr. Breithaupt has begun work with collaborators at the Apalachicola NERR, the University of South Florida, the University of Florida, and Auburn university to document temporal differences in sediment accumulation as well as retention of C, N, and P in the wetlands on the barrier islands. Specific attention is being given to changes in riverine influence on sediment deposition in the past century, as well as climate-driven habitat shifts from saltmarsh to mangroves. Results of this work will be important for quantifying the carbon and nutrient stocks and sequestration rates over time.
- A separate, but similar project involves partnering with the ANERR in their monitoring of surface sediment accretion and elevation change in freshwater and saline wetlands. This project will be comparing short-term data (sub-decadal timescale) with centennial timescale records of sediment accumulation and vertical accretion to identify how these coastlines have responded to changing hydrology in the past and how they may respond to sea level rise.

Dr. Andrew Shantz (https://marinelab.fsu.edu/people/faculty/shantz/) joined the ABSI research team a month ago (February 15th, 2021), and is still organizing his office and lab. His research merges principles from physiological and community ecology to understand how environmental change impacts the structure and resilience of coastal ecosystems. He uses hypothesis-driven field and lab-based experiments, behavioral studies, and meta-analytical syntheses to explore how changing conditions impact species' physiology and in turn, the cascading consequences for the ecosystems in which they live. Two of the major questions he is interested in addressing are:

- How do anthropogenic forces alter important species interactions, such as herbivory, predation, competition, and facilitation?
- What effects do these changing biotic interactions have on ecosystem function and resilience?

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