Citizen Science Quality Assurance Project Plan (QAPP)
for
Building a Data Set on Clam Recruitment and Survival
by
Freeport Police Department, Shellfish Committee, & Middle School

Prepared for
Casco Bay Estuary Partnership (CBEP)
and
U.S. Environmental Protection Agency (EPA)
Region 1

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Project Coordinator: Charles Tetreau, Marine Resource Conservation Officer/Harbormaster, Freeport Police Department

CBEP Director: Curtis Bohlen, Ph.D., Casco Bay Estuary Partnership, University of Southern Maine

EPA Project Manager: Matthew Liebman, Ph.D. Ocean and Coastal Protection Unit, Ocean and Coastal Protection Unit, EPA Region 1

This QAPP is based on the following EPA guidance documents: *Citizen Science Quality Assurance & Documentation Handbook, Templates, Examples, March 2019*

Approval Page

NORA CONLON Digitally signed by NORA CONLON
Date: 2020.10.06 15:55:05 -04'00'

U.S. EPA Quality Assurance Coordinator, Nora J. Conlon, Ph.D. Date

Matthew Liebman October 6, 2020

U.S. EPA Region 1 Project Manager, Matthew Liebman, Ph.D. Date

Oct. 6, 2020

Casco Bay Estuary Partnership Director, Curtis Bohlen, Ph.D. Date

9/11/2020

Freeport Marine Resource Conservation Officer/Harbormaster, Charles Tetreau Date

Sara Randall 9/12/2020

Freeport Shellfish Committee Member, Sara Randall Date

Elaine DesPres 9/11/2020

Freeport Middle School 7th grade Science Teacher, Elaine Despres Date

Problem Definition/Background

Casco Bay Estuary Partnership (CBEP) is engaged in ongoing efforts to understand the potential effects of climate change on Casco Bay. In 2020, CBEP awarded a community grant to Freeport for a citizen science project, "Hands-On Science Education: Building a Data Set on Clam Recruitment and Survival," submitted by the Freeport Police Department, the Freeport Shellfish Committee, and the Freeport Middle School. The project may take place in 2021 depending on when schools are re-opened after stay-at-home closures.

Maine is the top producer of soft-shell clams, *Mya arenaria*, in the United States (NMFS, 2019); however, landings in Freeport have declined by 75% since the early 1980's (Beal et al 2016) and the lowest recorded landings since 1930 occurred in 2017 (ME DMR). This decline corresponded with an obvious increase in sightings of invasive green crabs (*Carcinus maenas*) and as a result in 2013 the town of Freeport initiated a field-based "Shellfish Restoration Project" to 1) understand how trapping and deterring predators can reduce green crab predation on clam recruits (i.e., spat, or 0-year class individuals); and, 2) understand how reduced crab predation correlates with increased spat survival (Beal, 2014).

Further large-scale field research was conducted from 2014 to 2018 to investigate ways to enhance clam populations through 29 field experiments conducted at 81 field locations and green crab trapping. This research determined that the cause of the clam decline is predation, primarily on recruits, driven by warming sea water temperatures and invasive green crabs (Beal et al 2018). Over 99% of soft-shell clams are being eaten before they turn one-year-old (Beal 2019).

To determine clam recruitment and survival levels, the recruitment box was invented and first used in Freeport in 2015. In 2019 Ms. Despres led over 100 7th grade students through an initial data collection and processing of recruitment boxes. The students presented their results at the December meeting of the Shellfish Committee. This trial run helped to identify the best ways to prepare, collect and analyze the data with students, and also illuminated equipment needs. Improved equipment will ensure that data are collected accurately and efficiently. The next study will place recruitment boxes at a series of different tidal elevations.

Recruitment boxes are similar in concept to the passive settlement collectors used in the American Lobster Settlement Index (ALSI) that is used to predict lobster populations (The Wahle Lab, 2019). Similar to the ALSI, data from recruitment boxes allows shellfish programs to better understand the strength of an individual year class, and is useful as a predictor of future trends in recruitment and survival to the fishery.

Project Objectives

This project will enable Freeport Middle School's 7th graders, a class of about 100 students, to conduct authentic field-based research into clam recruitment, survival and growth in their own hometown. Following established protocols first tested in Freeport, and taught by their experienced science teacher Ms. Despres, the students will collect valid data about clams

recruitment, survival and growth. After an analysis of the results by the students they will share their findings with the Freeport Shellfish Committee.

Due to the previous research conducted in Freeport's intertidal zone, Freeport has the longest ongoing data set of clam recruitment, survival, and growth in the state. This project will greatly assist the town in continuing to collect information to build this data set. Much of the equipment purchased will be able to be used in subsequent years to continue the research.

The students' engagement in a research problem that begins with early life-history stages also serves to increase STEM education, as students will learn about concepts related to clam biology, shellfish identification, and intertidal ecology, as well as engineering and construction techniques related to building the boxes.

Engaging the younger generation in this field research will also raise community awareness of the fishery and help bridge the gap between Freeport's traditional livelihoods and newer residents. Parents will be interested in what their kids are doing at school and this interest may result in an increase of appreciation of the clamming industry and clams as an important local food.

In addition, by illustrating the impacts of warming waters on the survival of clams, it may lead to active adaptation measures to reverse the trend of decreasing clam abundance and landings. The work will enhance the public decision-making process and assist Freeport in efforts to value and preserve coastal and marine heritage. The continued collection of standardized clam recruitment data by the 7th grade students, combined with results from sampling recruits in ambient (control) sediments, will assist the Shellfish Committee in understanding the resource and result in a more informed decision-making process and a healthier, more robust fishery.

Downeast Institute's research has found that clam spawning is a protracted event rather than a single event. Recruitment occurs throughout the summer, but typically only the clams that settle in the fall are able to survive. That is because of the intense predation that occurs when the water is warm, once the water starts to cool the clams have a chance, and these are the clams that next year will make up the town's commercial stock. The data collected by the students will supplement and enhance statewide efforts to establish a soft-shell clam recruitment monitoring and survival network across the coast of Maine.

Project Summary, Location, and Schedule

The project is planned to begin in the spring of 2021, with the 7th grade students constructing recruitment boxes, corers, and sieves during their science classes. However, pandemic considerations may affect the schedule.

In 2017 the town of Freeport designated an intertidal area at Winslow Memorial Park for use by schools for research and educational purposes. Students will deploy the boxes at the town's designated school intertidal experiment zone prior to clam spawning season (May). Benthic core samples and water temperature will be taken.

Students will retrieve the boxes in November at the end of the clam growing season along with additional benthic core samples.

Students will identify the shellfish recruits and record the amount of clams from each box and sample. Size of the clams will be noted.

Many different analyses will be performed, including size distribution, comparisons between the amount of clams from the samples from the unprotected mud and the recruitment boxes, amount of other commercially important shellfish present, difference in tidal heights, etc.

Experience and Roles of Team

All key personnel have extensive training and experience in their respective roles and responsibilities.

Clammers: Most, if not all, of Freeport's 49 commercial clammers have participated in authentic intertidal field research during the time period of 2013 -2018. In 2014 and 2015, 98% of the town's clammers participated in a scientifically valid stock assessment and therefore have experience with core sampling, processing, and shellfish recruit identification. Their role is to provide technical assistance (i.e. box construction, deployment, sampling, processing).

Freeport Shellfish Committee Member, Sara Randall: Recruitment boxes were first deployed in Freeport in 2015, and the town is building a data set to help identify trends. Sara Randall has deployed and processed over 1,000 recruitment boxes in coordination with Freeport's clammers. Her role is to oversee experimental design, assist with data collection and analysis, coordinate deployment of boxes.

Freeport Middle School 7th grade Science Teacher, Elaine Despres: Ms. Despres has received training in how to conduct research with recruitment boxes. In 2019 she led over 100 7th grade students through an initial data collection and processing of recruitment boxes. Her role is to teach shellfish science and data collection methods, oversee project deployment and coordinate students.

Project Coordinator, Freeport Marine Resource Conservation Officer/Harbormaster, Charles Tetreau: As Marine Resource Conservation Office, Mr. Tetreau has extensive experience with clamming in Freeport. His role is to: divide tasks to ensure shellfish harvesters and middle school students will play a vital role in this study; ensure all dates and deadlines are met; coordinate conservation point initiatives with commercial clammers willing to help with study; lead coordination with the school; assist with site prep; assist 7th grade students in field and on land as needed. Team members will report to the Coordinator regarding this project.

Data Quality Objectives

1) To generate a hands-on, science-based field experiment that educates both clammers and students in the recruitment of shellfish species and how the shellfish industry is being affected by climate change.
2) To generate data that are sufficiently accurate to be utilized by the Freeport Shellfish Committee in decision-making.
3) To (a) determine if there is a significant difference in juvenile clam recruitment inside recruitment boxes versus control areas outside the predator-protected boxes; (b) determine if different tidal levels are affected differently by recruitment boxes.

Sampling Design and Data Collection Methods

Recruitment boxes, sometimes called "Beal boxes," are small rectangular units (1-ft x 2-ft x 3-inches deep) that are protected from predators by netting on the top and the bottom. Clams settle into the boxes and are able to survive and grow due to the exclusion of predators.

Students will construct approximately 45 recruitment boxes in science class. Students will use wood/plastic composite to construct approximately 30 1ft x 2ft x 3inch deep boxes with ground cover and pet screen secured to the top and bottom of the boxes. Composite will be precut to ensure all boxes will be identical. Boxes have different mesh, so we will be able to tell if there were more/less animals with different mesh sizes.

Layout of the boxes may include 15 boxes at each tidal height for comparison among tidal heights.

Freeport's clammers will pre-cut all material to assist students before boxes are constructed. Clammers will also be present during the set-up and break down of the project. Clammers will help with heavy lifting/assisting 7th grade class. Clammers will also assist during the processing stage (rinsing sediments out of samples and boxes) of the experiment.

Upon deployment the students will take benthic core samples using a standardized method (a coffee can with rubber "stoppers" inserted in the bottom). The coffee can is 6 inches in diameter and 6 inches deep. It will be used to take samples outside the boxes in the unprotected mud.

Approximately 15 core samples will be taken at random locations at each of the three intertidal gradients where the recruitment boxes are placed. Each core sample will be tagged with location (tidal gradient, sample #) and then processed by washing through a 1mm mesh sieve. All shellfish will be bagged and then counted and a subsample measured to determine growth rates. This process will determine the baseline densities of shellfish in the area at each tidal gradient.

Other parameters measured will include water temperature, which will be recorded using a hobo temperature logger. The thermometer is attached to the box throughout the experiment and collects water temperature in Celsius. Water temperature can affect the spawning and growth rate

of the shellfish. Warmer water is also directly related to increasing predation, which we may also find in the boxes.

The core samples taken with the coffee cans will serve as a control. Experiments conducted by the Downeast Institute in Freeport in 2018 showed that control boxes (treatments included boxes without netting on the top or bottom, or a partial top, without netting on the bottom, and without netting on the top) were no different from core samples.

These results demonstrate that the structure of the box is not attracting clams, but that predation is reducing clam abundance (predation regulates juvenile clam populations). The average densities in the controls were significantly lower than the full boxes (screening on top and bottom), and not significantly different than the average of the cores.

Students will retrieve the boxes in November at the end of the clam growing season along with additional benthic cores samples. Adjacent intertidal mud at the end of the field season will be sampled to determine how many clams survived the field season.

Approximately ten-fifteen core samples will again be taken from each of the three intertidal gradients and tagged with their location. Each core sample will be taken haphazardly within the same general area of the recruitment boxes, but not in the exact location of a single box.

Samples will be washed and processed on site at Winslow Park. Results will then be bagged and recorded in the classroom. Students will process the boxes and cores by washing the contents of each through a 1mm sieve. All clams and other shellfish will be placed into a bag along with their tag and taken back to the classroom.

Students will identify the shellfish recruits and record the amount of individual clams from each box and sample on data sheets. Clams will be counted to determine quantity of recruits settling in the area. The recruits will also be measured with calipers to determine growth rates (clams settle out of the water column at 1/5 of mm).

The clams in the tagged bags will be identified by Sara Randall and Elaine Despres while students measure them. When it is time for students to record the data, students will work in teams of two and be given a bag along with the number of soft-shell clam recruits already identified in the bag. Students will practice identifying and sorting the clam species and will only be allowed to start measuring when the teacher checks to see that the identification is accurate. Students will then work in teams of two and each soft-shell clam recruit will be measured twice. Recruits cannot be accurately measured more than twice as they are extremely fragile and prone to breaking.

The teachers are skilled in recruit species identification and will review and visually check all recruit identifications. While performing these checks we will be able see a pattern emerge that will likely hold through the entire tidal gradient. That is, all 15 boxes in the same tidal gradient will likely hold soft-shell clams in the amount of thousands, hundreds or less than 10. Samples containing thousands of soft-shell clams are clearly identifiable, likewise samples containing 10 or fewer clams. A data sheet that records much more or much less than the others in the tidal

gradient will be singled out and re-checked. An acceptable level of error for counting clams is 2-5%.

Many different analyses will be performed, including size distribution, comparisons between the amount of clams from the samples from the unprotected mud and the recruitment boxes, amount of other commercially important shellfish present, etc. The students will look at treatment effects (different types of predator protection through different size/types/arrangements of protective mesh: 3.2 mesh tops with ground cover bottoms, 3.2 tops with petscreen bottoms, petscreen tops with pet bottoms, pet tops with groundcover bottoms), and differences between tidal heights.

The densities between the boxes and the cores will be compared by seeing how many animals settle and survive using the boxes as protection from predation, and the cores are used as a control to see if anything is living/surviving without protection from predation.

All results will be recorded on Google Sheets which can easily be translated into graphs. Statistical data recorded will include: average number of recruits/box at three different intertidal heights compared to average number of clams in core samples at the three different tidal heights, number of green crabs found in core samples at different tidal heights compared to number of green crabs found in recruitment boxes at different tidal heights, and daily water temperatures from the day the recruitment boxes are placed in the mud until the day they are removed. A copy of the in-class data sheet is attached as Appendix A.

Documents, Records, Reporting

The tags that each sample or box is tagged with can be considered a field data sheet. The tags are roughly the size of an index card, and are waterproof. The tag shows the type of screen on the box and which tidal height it came from after being pulled from the mud. The tags are attached to the boxes so that when the boxes are retrieved and the animals inside counted, the collected data can be matched up to where the box was placed in the mud. After processing box contents through the 1mm mesh, the tag will be transferred to the plastic bag along with the shellfish for in-class data sheet. The entire contents of each box will be sieved.

The tags will be marked with cove (Winslow), date sampled, tidal gradient location (low, mid or high), and number (1-15). These tags will be either nailed onto the box upon end of the year sampling, or, in the case of the core samples, simply placed in the plastic bag upon core sampling. These tags are kept with the sample. Once the core sample is taken from the mud (using the coffee can) the coffee can is immediately emptied into a bag and the tag placed inside the bag. This is all done on the mud flat.

All students work under Ms. Elain Despres supervision and turn in their data sheet upon completion. She keeps all paper copies of data sheets and then personally transfers all the data to a Google Spreadsheet that is shared with all students for graphing and analyzing.

The copies of the data sheets will be stored and retained for 10 years. After 2 years the paper copies may be transferred to the town's Harbormaster Shack for storage with other Shellfish survey data.

Students will report findings via a slide show presentation to the Shellfish Committee along with all data collected.

Photos will include deployment of recruitment boxes in May, core sample collections for baseline samples, processing baseline samples, retrieval of recruitment boxes, processing of recruitment boxes and samples, sorting and measuring of clam recruits in the classroom, and pictures of students giving a presentation to the Shellfish Committee.

Student Training

Approximately 100 7th graders will be trained in shellfish identification. Sara Randall will help train students using pages from A *Photographic Guide to Seashore Life in the North Atlantic* field guide by J. Duane Sept. Randall has processed the contents of thousands of recruitment boxes (along with 34.5 tons of intertidal sediments from field experiments from 2013-2018) and is an expert in shellfish recruit identification. Children will mainly be writing numbers on the data sheets and each number has a separate line to write the number which help in keeping the information organized and legible. Also, when students hand data sheets to Elaine Despres she will check to see that they are legible before the tagged bags are deemed complete. Separating the data recording from the box and sample processing helps keep the sheets dry.

It is also possible we will put in a few extra recruitment boxes in order to provide some hands-on training before pulling in all the boxes to show the students how to pull the box out of the mud and handle a full recruitment box.

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Appendix A: In-class data sheet

2020 Soft-shell clam recruitment box study at Winslow Park

Tidal Height: High Mid Low (circle one)

Box type: Pet top & ground bottom 3.2mm top & ground bottom

Pet top & pet bottom 3.2mm top & pet bottom

Replicate: 1 2 3 4 5 6 7 8 9 10

11 12 (circle one)

Total number of soft-shell clams: _____

Measure a random sample of 25 individuals: _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

Total number of hard clams, *Mercenaria mercenaria*: _____

Measure all individuals: _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

Total number of green crabs, *Carcinus maenas*: _____

Measure the carapace width of all individuals: _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

_____ _____ _____ _____ _____ _____ _____

List other species found in the sample: _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

Notes: