

Citizen Science Quality Assurance Project Plan (QAPP)
For
Brunswick High School Green Crab, Water Temperature, and Soft-Shell Clam
Recruitment Study
By
Brunswick High School Marine Science Class

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

Date Submitted: May 12, 2023
Final Approval Date: June 30, 2023

Revision 0

Project Coordinator: Andrew McCullough, BHS Marine Science Teacher

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Title and Preparer Page

Project Name: Brunswick High School Green Crab, Water Temperature, and Soft-Shell Clam Recruitment Study

Effective Date of Plan: October 1, 2022 – October 31, 2027

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Signature & Date:  5-22-2023

Problem Definition, Background and Project Description

A. Problem Definition/Background

As the Gulf of Maine warms due to climate change, invasive species exploit these rising temperature changes and move into new ecosystems they might have previously avoided. The impact of these invasive species goes beyond simply upsetting an existing ecosystem, they can also disrupt commercial industries. In Brunswick Maine, High School marine science students have been researching and documenting climate change along the Coast of Maine through the use of their outdoor classroom at Wharton's Point in Maquoit Bay for several years. This outdoor classroom allows students to more easily collect data outside of the traditional classroom. Maquoit Bay is a popular softshell clam fishery and clammers have historically fished in this area for generations, however, these softshell clam populations have been declining in recent years due to predation. In an effort to document the impact of invasive green crabs on softshell clam populations in this area, Brunswick High School students hope to monitor water temperatures, collect and remove green crabs, and reintroduce immature softshell clams back into the ecosystem. Students will compare water temperatures and relative green crab densities to see if there is a correlation. Additionally, students will "seed" the area with baby soft shell clams to help regrow the population in Maquoit Bay.

B. Project Description:

Project Objectives:

The main objective for this project is to engage high school students in meaningful field studies and data collection that they might not otherwise experience in a traditional classroom. Students will be monitoring green crab populations and assisting the repopulating of softshell clams in the area. When conducting clam seeding, they will also monitor various predation protection measures. Students will follow protocols set forth by their marine science teacher Andrew McCullough. Over five years, we plan to have students measure water temperatures in Maquoit Bay, trap and collect green crabs, and analyze data related to green crab numbers and their effects on local soft-shell clam populations. We'll also be planting clam seeds to help rejuvenate the population. To this end, our specific objectives are as follows:

1. *To engage high school students in long-term, hands-on, and meaningful, community-based field data that they can then incorporate into classroom studies on climate change and human ecological impacts.*
2. *To see the impact of an invasive species and climate change on our local watershed.*
3. *To monitor and remove green crab populations affecting the bay's soft-shell clam populations.*
4. *To collect data on water temperature changes and any correlations between water temperatures and relative green crab populations.*
5. *To work with community partners to both share data and connect high school students with post high school opportunities.*
6. *To help support rejuvenation of the native softshell clam population in Maquoit Bay.*

Project Sites or Study Area/Time Period:

Students will be conducting research at Wharton's Point, a public access area on Maquoit Bay, a part of the larger Gulf of Maine. Wharton's Point is a popular public area utilized by many clammers and the public.

Students will set green crabs traps in late April and begin monitoring them immediately, collecting crab samples through until the following October. Clam seed will be planted in May and then monitored until late October when protective coverings will be removed. Water temperatures at the green crab trap sites will be monitored continuously from April-October through the use of data loggers.

Data Users:

BHS Marine Science Teacher, Andrew McCullough will be the sole holder of all data collected. Mr. McCullough holds a BA in Biology and a Masters in Teaching and Learning. He has worked as an environmental educator and classroom biology teacher for over 20 years. He has received specific training through the Downeast Institute on proper clam seeding techniques and green crab collection and data monitoring. Other potential users for this data as either individuals or groups might include the following:

- Communities or researchers studying correlation between water temperatures and invasive species.
- Communities or researchers seeking information on relative green crab populations in Southern Maine.
- Communities or researchers looking for information on water temperature fluctuations in Maquoit Bay from May-October.
- Communities or individuals studying effects of habitat loss or predation on soft-shell clam populations.
- The Town of Brunswick may be interested in data collected as it might be meaningful for future ecological or economic projects concerning Maquoit Bay and Wharton's Point.
- Victoria Boundy, the Community Engagement Coordinator for Casco Bay Estuary Partnership, is a potential data user as grant money from this organization helped fund the purchase of materials and supplies.

Data Quality Objectives and Indicators

A. Data Quality Objectives

Please note: The primary goal of this project concerning data collection is to collect primary data and present that data to any interested parties without analysis.

Water Temperature:

To ensure quality when collecting data on water temperatures in Maquoit Bay, the following protocols will be utilized:

- All temperatures will be collected using HOBO brand data loggers that will take readings of water temperature every 5 seconds through the study period. Prior to deployment loggers will be calibrated by us to take these 5 second temperature readings continuously until their batteries die, which is typically after 4-5 years. These loggers are designed to be continuously submerged without fear of contamination. We will periodically check all loggers for damage and to ensure they are still functional.
- All temperature readings will be collected from the HOBO data loggers using HOBO brand software and stored on both a primary computer and a back-up hard drive. Data loggers will be named after the trap number they are attached to in order to decrease confusion when using the software.

- Data loggers will be secured on green crab traps using zip ties in the same place on all traps. Traps and data loggers will be stationed at a variety of locations along the shoreline dependent on accessibility.
- To account for quality in our water temperature readings (dependent variable) the following independent variables will be kept the same: Brand/type of data logger, location of data logger on green crab trap, duration of deployment of data logger, and equipment/software used to collect temperature readings from data loggers (data from loggers will be collected at end of season). The only independent variables changed will be location of data logger along the shoreline and duration of time data loggers are submerged due to tidal fluctuations along shoreline (some data loggers may have a higher amount of time out of water as they may be placed closer to shore).

Green Crabs:

To ensure quality when collecting data on green crabs at Wharton's Point, the following protocols will be utilized:

- The same brand and style of crab trap will be used for all testing sites.
- Traps will all be baited with the same type of bait.
- Soak times will be the same for all traps.
- All crabs collected will have the following data collected from them: Trap caught in, sex, carapace size, and color.
- All crabs collected will be humanely euthanized through freezing in the same chest freezer located at Brunswick High School.
- All crab carapace measurements will be collected using the same brand pre-calibrated calipers in the lab at Brunswick High School.
- Students collecting data will be trained and supervised by Andrew McCullough.
- In the lab at Brunswick High School, all crab data collected will be double checked by peers before being entered into database.
- In the field, when collecting crabs from traps, students will work in teams assigned to specific traps to ensure accuracy and decrease chances of confusion while collecting specimens. All traps will be emptied using the same methodology to ensure crabs are not lost on transfer from trap to bag. Students will personally transfer bagged specimens to freezer to ensure proper chain of handling.
- All specimens collected from traps will immediately be put into a pre-labeled (with trap number and date) zip-lock bag. These bags will then be transported back to the Brunswick High School to be put in the freezer. Specimens will then be analyzed at a later date.
- To account for quality in our information collected regarding green crab populations and individual green crabs, the following independent variables will be monitored and kept the same among all crab traps and specimens collected: Duration of soak times for traps, brand/style of trap used, bait used, data collection tools, specimen collection and identification methods, and proper handling of specimens during and after collection. The only independent variables changed will be location of traps and exposure to air due to tidal fluctuations.

-During the months of April, May, June, September, and October, crab traps will be checked and emptied by Mr. McCullough's marine science class. During the summer months of July and August, student volunteers will check all traps dependent on individual schedules.

Clam seeding:

To ensure quality when seeding soft-shell clams under nets, the following protocols will be utilized:

- Clam seed will be kept monitored and stored in large salt water aquarium tanks at Brunswick High School for the duration of time between purchase and seeding.
- The same netting material and staking materials will be used for all plots.
- All plot set up will occur on the same day and be monitored from May to October when the netting will be removed.
- Nets will be secured by stakes at all four corners and with two further stakes evenly spread out on all sides.
- Approximately five thousand clams will be spread per plot area.
- Clam seed will be handled appropriately at all times to ensure as many viable "seedlings" as possible.
- When nets are removed in October, students will remove them at the direction of Andrew McCullough to ensure no trampling of plots occurs and the plotted areas are disturbed as little as possible. All nets and traps must be removed before ice forms so data will only be collected April-October.
- All plots will be set in the same substrate.
- All plots will be clearly noted with florescent orange stakes marking each corner.

Clam "pots":

- If/when clam "pots" are placed along the shore line (this will be dependent on time and other school curriculum goals being met), all pots will be designed and constructed in the classroom before deployment.
- All pots will be photographed before placement to record noteworthy structural adaptations from student engineering.
- All pots will be buried in the mud up to the rim of the pot.
- All pots will be marked with 1-3 florescent orange stakes, dependent on size of pot.
- All pots will be filled with the appropriate amount of clam seed depending on size and shape of plot. No pots will contain seed in a less than 1in. spread.
- Original amounts of clam seed placed in each pot will be recorded in May and stored in a file on Andrew McCullough's laptop with a hard-drive back up.
- When pots are removed from the mud in October, numbers of clams left inside of pots will be counted and recorded by students and uploaded individually onto data sheets so that data is presented as "amount of seed before" and "amount of seed after".

Project Objectives:

- To develop field-based data collection techniques that educate high school students and the general public about threats to local softshell clam populations
- To collect data that is sufficiently accurate to be used by the community and local schools as needed.
- To measure water temperature in multiple locations over a 6 month period.
- To determine relative densities of local green crab populations as well as data concerning crab size, sex, and other identifying features.
- To determine if there is a significant difference in survival rates of softshell clam housed under just netting (to protect against green crab) and housed on four sides (to protect against worm and crab predation)

Sampling Design and Data Collection Methods

Green Crabs:

Green crab traps will be set at 15 foot intervals along approximately 200 feet of shoreline. This section of shoreline constitutes the area accessible to the public at Wharton's Point. It also includes several various substrates including loose mud, packed hard mud, and areas of freshwater run off. Crabs will be collected from traps with a minimum of 5 days between collections but no more than 14 days between collections. Traps will be visually checked from shoreline both at times of emptying and periodically during the week to ensure none have been damaged or moved. Only green crabs will be collected, all other species will be discarded and returned. Each trap's contents will be bagged and dated and then frozen for later study. In the classroom, crabs will be removed from freezer and studied individually by Mr. McCullough's marine science students. The following data for each crab will be recorded:

- Carapace size (as measured by diameter across outer points of shell using caliper)
- General color (green, red, orange, or yellow)
- Sex

All data will be entered onto a data sheet which will include place of collection and date/time of collection. This data can be used for further studies comparing general information about crab statistics related to location of collection (i.e. substrate differences) at a later date if desired.

Softshell Clams:

Each Spring approximately 15k softshell clam seeds will be purchased. Under 2 nets measuring 10ft x 10ft, students will spread approximately 5k clam seeds per net. Each net will be secured at the corners with stakes and the edges folded down in the mud, preventing predators from accessing the clams from the surface. Both nets will be monitored from May-October to ensure edges are not pulled up with the tides and all nets stay in place. In October, nets will be removed and students will conduct 3 plots (1ftx1ft) in random areas previously covered by nets to determine relative densities of yearling clams under the nets. Random areas will be chosen using a random number generator and a grid pattern (see addendum 1 with diagram). Separately, other quadrants of 10ftx10ft will have been marked and not

covered or seeded. Students will also conduct random 1ft² plots in these quadrants to determine relative densities of yearling clams in areas with no seeding or netting.

The remaining 5k baby clams will be separated and distributed to students for placement in “flower pot containers” designed by students. These containers (named after their original iteration of actual flower pots) will be engineered by students in the classroom and will take into account several different independent variables including substrate depth, type of netting, and type of wall material. All constructed pots will be pre-approved by Mr. McCullough, and like the nets, all parts of pots will be removed from the mud in October. In October when pots are collected clam survival will be counted in each pot by students to try and determine any correlations between clam survival rates and the variables accounted for in each pot.

Water Temperature:

HOBO water temperature data loggers will be fixed to each green crab trap. These data loggers will record a water temperature reading every 5 seconds. All water temperatures will be collected at the end of a six month period, although loggers will be visually checked for damage every 1-2 weeks. Should a data logger ever become ineffective during the duration of study, a new logger will be installed. Should a logger not collect data and be missed until the end of the six month cycle, that trap will be taken out of the data set. This data can be used to both show overall temperature changes across the six month period, but also be correlated to amounts of green crabs caught in individual traps.

Documentation:

When collected, all crabs will be labeled by bag according to trap collected from and date. In the classroom, all individual crab data will be recorded on data sheets as indicated below. Clam densities under both netting and in pots will be recorded on a google data sheet that will then be accessible to anyone that requests it. All documents will be recorded by students under the supervision of Andrew McCullough and he will retain hard copies of all documentation collected.

Student Training:

Prior to going into the field, approximately 20 marine science students will be trained by Andrew McCullough. Mr. McCullough will instruct students on Green Crab identification using Peterson Field Guide to the Atlantic Seashore. All samples will be checked once when being removed from traps and a second time before being taken back to the classroom.

Project Schedule

Activities	Group/Person responsible for activity completion	Timeframe work will be done
<i>Green Crab trap placement</i>	<i>BHS marine science students</i>	<i>Late April-Early May depending on weather and tides</i>
<i>Green Crab collection</i>	<i>BHS marine science students</i>	<i>Bi-weekly from May-October</i>
<i>HOBO Data Logger placement</i>	<i>BHS marine science students</i>	<i>Late April-Early May depending on weather and tides</i>
<i>HOBO Data Logger Data Collection</i>	<i>BHS marine science students</i>	<i>Twice per year, once in June, once in October</i>
<i>Softshell clam seeding</i>	<i>BHS marine science students</i>	<i>Once per year in late May depending on weather and tides</i>

Training and Specialized Experience

A. Training

Personnel/Group to be Trained	Description of Training (Including Trainer(s))	Frequency of Training
<i>BHS Students</i>	<i>Green Crab Identification including size measurements and sex ID -Trained by Andrew McCullough, BHS marine science teacher</i>	<i>Twice per school year</i>
<i>BHS Students</i>	<i>HOBO data logger data collection -Trained by Andrew McCullough, BHS marine science teacher</i>	<i>Twice per school year</i>
<i>BHS Students</i>	<i>Softshell clam Identification including relative aging -Trained by Andrew McCullough, BHS marine science teacher</i>	<i>Twice per school year</i>
<i>BHS Students</i>	<i>Effective softshell clam seeding techniques including net placement and protection device construction -Trained by Andrew McCullough, BHS marine science teacher</i>	<i>Twice per school year</i>

B. Specialized Experience

Person	Specialized Experience	Years of Experience
<i>Andrew McCullough</i>	<i>Marine Science Education</i>	<i>14</i>

Documents, Records, and Reporting

The tagged bags that crabs are collected into will be considered a field data sheet. These bags will be marked with location (Wharton’s Point), date sampled, and trap number. All samples will be kept in these same bags until crabs are analyzed in the classroom. When processing the crabs in the classroom all information will be recorded on data sheets as outlined below:

Sample Data Sheet:

All students work under Mr. Andrew McCullough’s supervision and turn in data sheets upon completion. He will keep all hard copies and personally transfer data to a google spreadsheet to share with students for analysis. All students will be given a copy of this QAPP before data collection begins. Students will go over the QAPP with Mr. McCullough in the classroom before going into the field to collect data.

Copies of all data sheets will be stored and retained for 10 years in Mr. McCullough’s filing cabinets in his classroom. Students will report findings to the BHS science department.

Photos of crab traps, data collection, and softshell clam seeding will be collected throughout the project.

Sample Data Field Sheet for trap collection:

Trap Number:	Collected By:	Date:	Notes (Including substrate trap was found in):

Sample Data Field Sheet for Green Crab Identifications (Done in classroom)

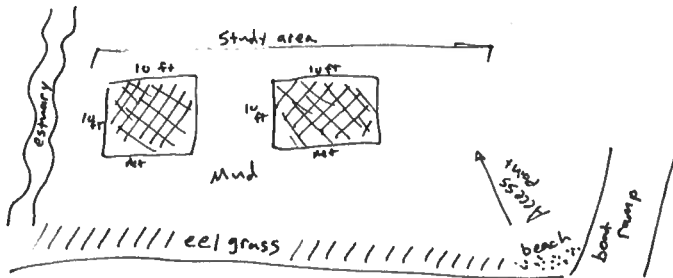
Trap Number:
Date Collected:

Color:	Color:	Color:	Color:	Color:	Color:
Sex:	Sex:	Sex:	Sex:	Sex:	Sex:
Carapace:	Carapace:	Carapace:	Carapace:	Carapace:	Carapace:

Color:	Color:	Color:	Color:	Color:	Color:
Sex:	Sex:	Sex:	Sex:	Sex:	Sex:
Carapace:	Carapace:	Carapace:	Carapace:	Carapace:	Carapace:
Color:	Color:	Color:	Color:	Color:	Color:
Sex:	Sex:	Sex:	Sex:	Sex:	Sex:
Carapace:	Carapace:	Carapace:	Carapace:	Carapace:	Carapace:

Addendum 1:

Placement of clam nets at Wharton's Point: Location:



10ftx10ft clam net with grid to determine random areas of sampling:

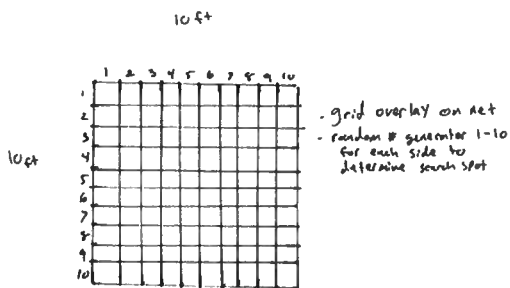
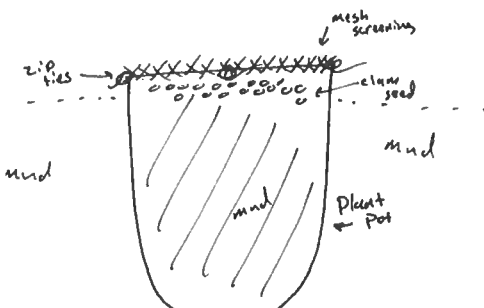


Diagram of "Flower Pot" for potential use for clam protection:



** Please note any data collected prior to approval of this QAPP followed all outlined procedures indicated herein.*